Materials & Methods

THE MAGAZINE OF MATERIALS ENGINEERING

Progress in Industry Awaits Developments in Engineering Materials

Alternate Steels Useful as Substitutes for Critical Materials

Brazing in Salt Baths Offers Production Economies

Silicone Elastomer Retains Properties Over Wide Temperature Range

Hot Machining of Many Metals Improved by Arc Heating

Liquid Flame Hardening Used to Selectively Harden Steel Gear Teeth

How to Select Nonferrous Alloys for Investment Castings

Welded Narrow Steel Sheet Used for Wide Stampings

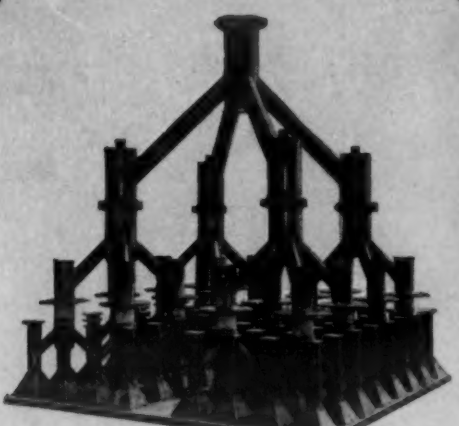
New Blackening Bath for Ferrous Metals

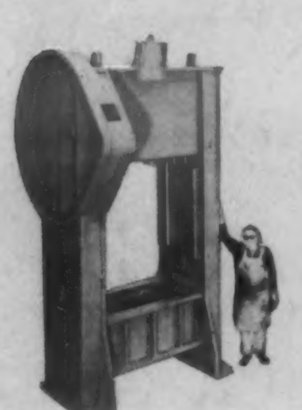
Solders and Brazing Materials

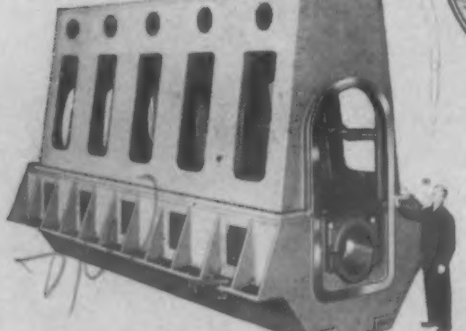
Review of Materials Engineering Developments in 1950

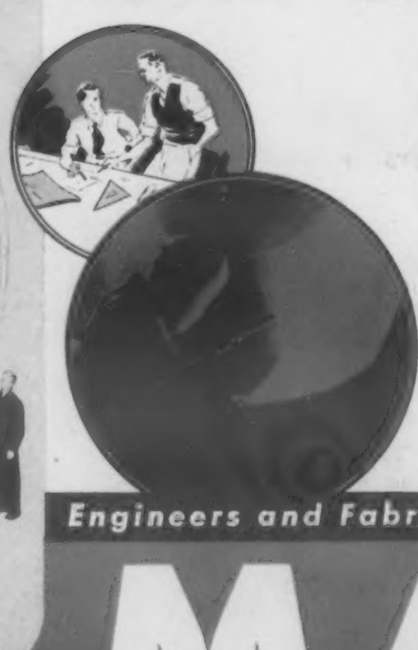
Materials & Methods Manual No. 66

January 1951









Index of Feature Material

MATERIALS & METHODS

Volume 33

January—June 1951, Inclusive

Feature editorial matter from Volume 33 of MATERIALS & METHODS covering issues from January through June 1951 is indexed here. Material covered in the index includes feature articles, MATERIALS & METHODS Manuals, and Engineering File Facts.

Authors' Index

Materials & Methods®
THE MAGAZINE OF MATERIALS ENGINEERING

VOLUME 33, NUMBER 1 JANUARY 1951

Published monthly by Reinhold Publishing Corporation, 330 West 42nd St., New York N. Y., U. S. A. Ralph Reinhold, Chairman of the Board; Philip H. Hubbard, President; H. Burton Lowe, Executive Vice President; F. P. Peters, Vice President and Secretary; W. P. Winsor, Vice President; E. Cochran, Vice President; J. G. Belcher, Vice President; Merald Lue, Vice President; Francis M. Turner, Vice President. Price 50 cents a copy. Payable in advance, one year, $2.00; two years, $3.00; three years, $4.00; five years, $5.00 in U. S. and U. S. Possessions and Canada. In all Latin American countries: one year, $10.00; two years, $16.00; three years, $20.00. All other countries: one year, $15.00; two years, $25.00; three years, $30.00. (Remit by New York Draft.) Printed by Lotus Press, Inc., 508 West 26th St., New York 1, N. Y. Reentered as second class matter Nov. 14, 1945, at the Post Office at New York, N. Y. under Act of March 3, 1879. Established in 1929 as Metals and Alloys.

FEATURE ARTICLES

MATERIALS & METHODS MANUAL NO. 66

ENGINEERING FILE FACTS

DEPARTMENTS

NEXT MONTH: Titanium and Titanium-Base Alloys . . . Welding of Plastics . . . Case Hardening Steel . . . Diamond Powders as Abrasives . . . Designing Steel Castings . . . NONDESTRUCTIVE TESTING (Materials & Methods Manual No. 67)

The Materials Outlook

WASHINGTON, D.C. -- The long-range implications of recent Washington developments on the materials front are vast, although changes to be felt in the immediate future may be slight. As the military demands increase the National Production Authority will turn out more orders limiting the use of materials in which shortages have developed or where shortages seem imminent.

With the recognition in Washington of a much more serious military situation than had been admitted previously, controls and restrictions are likely to come faster and be more stringent. However, effective enforcement of any regulations cannot be effected for many months because of the lack of personnel. It has been pointed out that at the height of the OPA during World War II more than 90,000 employees were used to administer the department. Any presently available staff will number less than 10% of the number.

There have been many rumors that a controlled materials plan, commonly known as CMP, is ready to be invoked immediately. There is little chance of this happening before next summer because a minimum of six months will be required to man the necessary organization. However, it is almost a foregone conclusion that such a plan will be invoked, for it is inevitable that inequities will develop under the current system of allocations.

Publicly, at least, there has been no indication of how much faster the war production program will be accelerated and what date has been determined as a point at which peak production is desired.

For a while, contrary to a belief in some quarters, there will be no definite cut-backs of specific products. Curtailment of production will come about through materials scarcities and by the return of government plants to war production. Present plans are to keep civilian goods output as high as possible so as to disrupt the economy as little as is necessary.

Now that most of the important metals have been covered by various types of orders, we can expect to hear soon the results

(Continued on page 4)

The Materials Outlook *(Continued)*

of a long series of meetings with the chemical industry. Investigations have been made into supplies and needs of many chemicals that are important to metal production and metal processing as well as to the plastics industry.

Incidentally, even though there are some severe shortages in plastics, particularly the styrenes, there does not seem to be any activity underway to regulate the uses or supplies. In some quarters there is a feeling that changes in the synthetic rubber program might ease the tight supply of benzene, which has caused the scarcity of styrenes. That group of plastics was the fastest growing of all those in current use when shortages stopped expansion of plans.

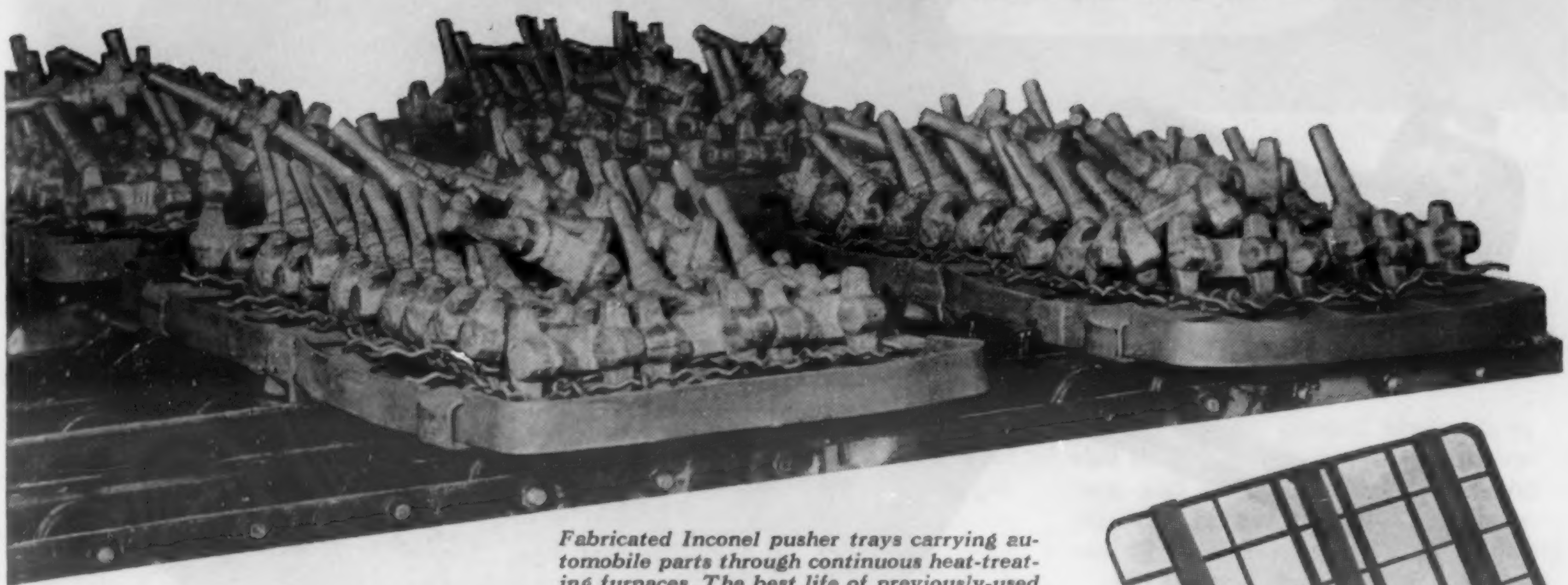
Even though procurement activity seems slow, the rate of military spending will grow steadily until it reaches a level of about $3 billion a month by June 30. The Military is strong in its stand to avoid total mobilization for a long time -- or until war should break out over a wider front. They want to build up rapidly but not so fast as to disrupt the entire economy, feeling that the latter would play into the hands of the Russian thinkers.

President Truman has given Charles E. Wilson powers broader in three respects than those of his forerunners: (1) He vested in Wilson, subject only to his approval, all his powers to control under the Constitution and as Commander in Chief of the Armed Forces, as well as under the Defense Production Act. (2) President Truman gave Wilson power to direct, control and coordinate (not just coordinate). And (3) He gave him power over all the war-control agencies, and any federal activity connected with the mobilization for war production. He can legally override a member of the Cabinet with respect to action taken in the Cabinet members' own department, and he can affirmatively "direct," not merely veto.

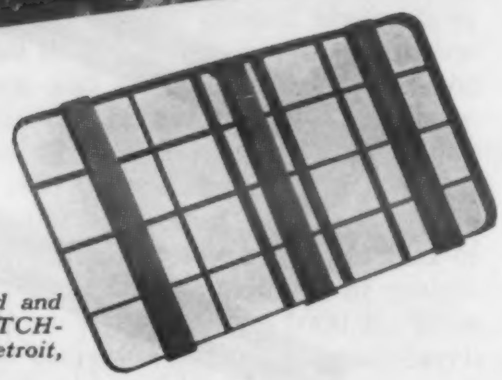
This shift of power is important in the controls picture and in the materials picture. It means: (1) One of the foremost production industrial executives of the country is in charge. He knows the industrial machine, and he knows the hang of government. He is a conservative. This augurs for more soundness in the administration of controls. (2) Wilson savvies the machinations of bureaucracy, from his experience as vice chairman of WPB, where he faced constant knifing. In fact, Wilson so knows his way around Washington that he insisted before taking the job that he, Wilson, should run the show subject only to the President, not subject to Symington. So Symington was sent to the backfield of the controls picture for the present.

Meet a *LIGHT-WEIGHT* champion..

Inconel pusher trays still going strong on a job that licked heavier furnace trays!



Fabricated Inconel pusher trays carrying automobile parts through continuous heat-treating furnaces. The best life of previously-used trays averaged nine months. The fabricated Inconel trays have been in use over one year.



Inconel pusher tray designed and fabricated by BROWN-HUTCHINSON IRON WORKS, Detroit, Michigan.

- **Furnace production increased**
- **Tray life increased**
- **Maintenance costs reduced**

These substantial benefits are what a large automobile manufacturer gained by switching to fabricated Inconel* pusher furnace trays.

Previously-used trays weighed from 114 to 198 pounds each. The fabricated Inconel trays weigh only 86 pounds... a weight saving 28 to 112 lbs. per tray. Based on average net load of 400 pounds this represents a gross weight saving of 5 to 19% over previous equipment.

Even more important—these lighter-weight fabricated Inconel trays last longer, with correspondingly reduced replacement and maintenance costs.

This fine performance record is even more remarkable when the severity of service conditions are considered. During the heat-treating of automobile parts, the trays are subjected to temperatures as high as 1650° F., followed by oil quenching.

The furnaces, which are gas-fired and non-atmosphere in type, present high-temperature corrosion problems. Add to these punishing conditions the considerable mechanical forces acting on the trays... up to 540 pounds load plus 2000 pounds thrust from the hydraulic pusher mechanism... *and you have service conditions that demand Inconel plus good fixture design.*

Brown-Hutchinson Iron Works are designers and fabricators of these pusher trays. They, like other leading fabricators, used Inconel because of Inconel's outstanding performance record and desirable combination of physical characteristics . . . thermal durability, corrosion-resistance, high hot and cold strength, workability, economy.

Although Nickel and Nickel Alloys are currently in short supply, Inco advertisements will continue to bring you information on industrial processes and developments which we believe will be of interest.

**Reg. U. S. Pat. Off.*

EMBLEM OF SERVICE INCO

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

INCONEL* ...for long life at high temperatures

News Digest

Molybdenum Alloy Development Reviewed by ASME

The annual meeting of the American Society of Mechanical Engineers held last month in New York City produced a number of papers of special interest to the materials engineer. Perhaps chief among these is a report called "An Introduction to Arc-Cast Molybdenum and Its Alloys," presented by J. L. Ham of Climax Molybdenum Co.

Arc-Cast Molybdenum

Because of its high melting point, molybdenum is a logical choice for a base metal in alloys for high-temperature applications. The recently developed arc-cast process, which converts powder to cast ingots, makes molybdenum available in larger sections than heretofore possible. It appears that the size of ingot which can be produced by the arc-cast method is limited only by the capacity of available electrical and vacuum equipment. According to the author, ingots up to 6-in. dia and 150-lb weight are now being produced, and equipment for the production of 9-in., 1000-lb ingots is under construction.

Pure molybdenum is relatively soft as cast, ranging from 170 to 190 VPN, but hardens rapidly on working and may reach 300 VPN after severe cold work. Complete recrystallization reduces hardness to that of the as-cast metal, or slightly below. After sufficient working, tensile properties depend primarily on annealing temperatures. For an annealing temperature of 1800 F, tensile strength is about 91,000 psi, elongation 41% and reduction of area 64%. For 2100 F, tensile strength drops to 73,000 psi, yield point is 54%, elongation jumps to 56%, and reduction of area remains at 64%. After annealing at 2500 F, these values are 71,000 psi, 43,000 psi, 57% and 63%.

Pure Metal Properties Studied

Measured by the Charpy notched-bar impact test, molybdenum is brittle at room temperature. However, impact properties improve abruptly at higher temperatures. Since unrecrystallized molybdenum has been found more resistant to impact, full recrystallization is not recommended except where service above the recrystallization temperature is anticipated, or where it is necessary to prepare the metal for further working.

The limited data available indicate that, above 1600 F, creep and stress-rupture properties of pure molybdenum are superior to those of any of the cobalt-, iron- or chromium-base alloys, provided that a protective atmosphere or coating is used.

Since applications for pure molybdenum are restricted by its limited strength at high temperatures, development of stronger molybdenum-base alloys is of considerable interest. The Vickers hot-hardness test has proved to be a convenient criterion for selecting materials likely to possess strength at high temperatures. For this reason, the authors used hot-hardness tests to evaluate tentatively various alloy additions to molybdenum.

Binary Alloys Are Stronger

Results of this investigation show that, at 1400 to 1600 F, small additions of beryllium, nickel, silicon, cobalt, iron, chromium, aluminum and zirconium, in that order, markedly raise the hardness of molybdenum. These general observations also hold roughly at room temperature, and incomplete tests show that they can be extended to a temperature of 3000 F.

All alloy additions which significantly increased hardness were found to complicate the problem of fabrication. The hardness of molybdenum is 70 VPN at 1600 F. With the exception of molybdenum-beryllium and molybdenum-zirconium alloys, it has so far been possible to forge only those alloys whose hardnesses at 1600 F do not exceed 90 VPN. However, additions conferring lesser increases in hardness have been found sufficient to raise the degree of work-hardening and the recrystallization temperature of worked alloys to a useful extent. It appears that, if suitable dies could be obtained, it would be possible to make extrusions from alloys with initial hardness at 1600 F as high as 180 VPN.

Some of the applications being investigated for molybdenum alloys are piercing plugs for seamless steel tubing; gas turbine blades; electrodes for heating molten glass; die casting dies for brass and other nonferrous metals; certain components of turbojets, ram jets, rockets and nuclear reactors; and parts exposed to corrosive chemicals.

Hot Machining of Metals

The recent surge of interest in hot machining was reflected in a report on "Basic Factors in the Hot Machining of Metals", presented by E. J. Krabacher and M. E. Merchant, of Cincinnati Milling Machine Co.

Their research showed that the

(Continued on page 8)

News Digest

lower cutting forces and consequent lower power consumption achieved by hot machining are due mainly to reduced shear strength of the work material at high temperatures. However, it does not follow that tool life will always increase with increasing workpiece temperature. For any given work material, there is a definite temperature range for which tool life will be an optimum; for some materials this optimum occurs below room temperature and for some it occurs above 1500 F.

The authors found that the tool life obtained with a given work material depends mainly on two factors: (1) tool-chip interface temperature, and (2) abrading action of the work on the tool. Both are controlled by the mechanics of cutting. Specifically, the product of thrust force and interface temperature appears to provide a rough quantitative measure of these two factors.

Another subject of increasingly wide interest was covered briefly by D. C. Bradley, New Jersey Zinc Sales Co., in "Some Design Aspects of Metal-Powder Parts." His paper summarized the properties of powder metal parts and discussed design considerations and limitations with respect to typical forms and component parts. According to the author, new applications for powder metallurgy are constantly appearing as more and more companies become aware of the savings and other advantages of designing for the process.

Cast Steel Valve Study

Low alloy steels have been used in steam power generating units for temperatures up to above 1000 F. However, some steels have shown a tendency toward graphitization after long service at 900 F or above. Two researchers, T. N. Armstrong and R. J. Greene, of The International Nickel Co., selected for study a 4-in., 900-lb slide valve which had been in continuous operation at 900 F and 840 psi for a period of 6 yr. In a paper titled "Nickel-Chromium-Molybdenum Steel Valve Casting After 50,000 Hours Service at 900 F," they

(Continued on page 134)

Strategic Materials Reduced in New Jet Engine

Major reductions in the use of strategic materials have been achieved in the J-47-GE-17 aircraft jet engine, according to General Electric Co., which unveiled the new engine recently.

C. W. LaPierre, manager of the Company's Aircraft Gas Turbine Divs. at Lynn, Mass., says this reduction from the strategic materials content of the basic J-47 engine now powering Air Force planes may reach even greater proportions with the incorporation of further, planned substitutions. The less strategic materials have been substituted without any anticipated sacrifice in engine life or performance.

The J-47-GE-17, equipped with an afterburner, will power the Air Force's F-86D interceptor, an even faster version of the world speed record-holding F-86, which is being manufactured by North American Aviation, Inc.

Press Tours Jet Plant

The above information was just part of a vast amount reeled off to the nation's press during a recent two-day tour of the closely-guarded Lynn plant. For the first time, civic leaders, high-ranking Air Force and Naval officers, and the press saw the GE River Works where precision-made aircraft jet engines are produced on an assembly line basis to meet expanding military needs. Here, this country's first jet engine had been developed amid World War II secrecy.

The inspection covered the entire range of manufacturing operations, from the processing of raw materials into finished parts at the nearby Everett plant to the loading of completed engines into specially-built cylinders for shipment to the Air Force. Also seen were the forging operations and the manufacturing processes that were involved in the turbosupercharger manufacture and assembly.

New Laboratory Dedicated

Earlier, dedication ceremonies were held for a new laboratory where the component parts of jet engines are operated under test conditions never before attained. The laboratory was dedicated to the late Dr. Sanford A. Moss, who created the forerunner of modern turbojets 47 years ago, and later won aviation fame as the "father" of the turbosupercharger which enables aircraft to fly in the thin air of high altitudes.

The recently unveiled J-47-GE-17 is said to be the nation's first jet engine to incorporate major reductions in strategic materials.

This was the first public glimpse of the testing set-up where altitudes of 70,000 ft and temperatures of −100 F can be simulated. The laboratory is used for full-scale and model-scale testing of compressors and combustion systems.

Latest Welding Developments Reported at AWS Meeting

News Digest

The American Welding Society's Annual Meeting, held during the Metal Show at Chicago the week of Oct. 21, provided a large and varied selection of technical papers which, taken altogether, give an excellent picture of recent progress in the welding field. Space does not permit digesting all of the some hundred papers which were presented; therefore, only those which would seem to be of most interest to our readers will be discussed.

Inert-Gas Metal-Arc Welding

The inert-gas metal-arc welding process continues to hold the spotlight in the welding industry, mainly because it permits satisfactory welding of materials which are difficult to join by the older processes. The paper, "Aircomatic Welding of Copper-Base Alloys", by H. Robinson and J. H. Berryman, covered the present status of welding copper-base alloys with the consumable electrode method of inert-gas metal-arc welding. The most successful applications to date have been with aluminum and silicon bronze alloy electrode wires. These two alloy wires have superb weldability and high deposition rates, and produce x-ray-sound welds of excellent surface appearance and high physicals. Spatter loss is usually less than 2%.

Several of the popular grades of austenitic nickel-chromium steels have been welded by the inert-gas metal-arc process. The paper, "Aircomatic Welding of Austenitic Chromium-Nickel Stainless Steel", by W. G. Benz, Jr. and J. S. Sohn, presented the results of several tests of such weldments in the as-welded, annealed, sensitized and stabilized conditions. The tests included tensile tests, impact tests at different temperatures, and hardness traverses in all-weld metal specimens. Corrosion resistance was also evaluated. Microstructure studies showed that the presence of delta ferrite in the weld metal can be correlated with chemical composition of the filler wire.

J. W. Mortimer in his paper, "Welding Aluminum with Inert Arc D.C.", discussed the advantages of welding aluminum using direct current and helium gas. Advantages cited are: (1) the cost of standard d.c. motor generator sets is about one-third to one-quarter that of a.c. high-potential, high-frequency units for the same output rating; (2) there is no radio interference; (3) the cost per tank of helium is roughly 74% that of argon.

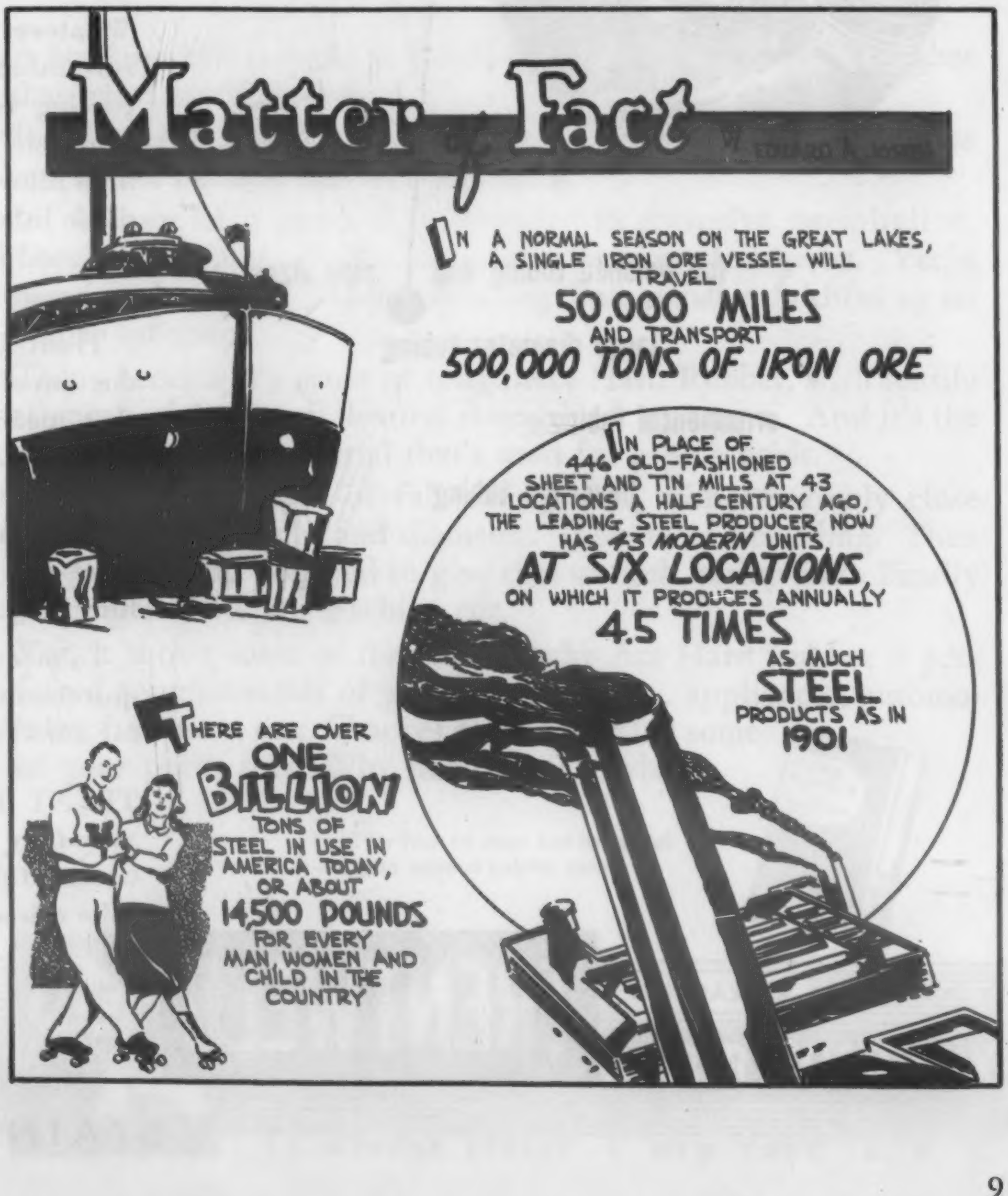
A paper on "Jigs and Fixtures for Inert-Gas Arc Welding", by H. A. Huff, Jr. and A. N. Kugler, provided fundamental data on design of jigs for this welding process. Some of the items covered included methods of providing fixed clamp bars with movable backup, the importance and design of backing elements, and techniques for jigging cylindrical seams.

Submerged Arc Welding

A new method of submerged arc welding using multiple electrodes was described by E. L. Frost in his paper, "Welding with Multiple Electrodes in Series in Submerged Melt Welding". Conventional submerged melt welding techniques produce welds which have deep penetration into the base plate material and are deposited at high rates of travel speed. For applications requiring cladding with dissimilar metals, such as stainless steel or nonferrous materials, or building up of local areas on relatively thin base metal, minimum penetration and dilution of the deposit by melted parent plate metal are desired. By connecting two or more electrodes in series electrically with each other and electrically insulating the base plate from the welding circuit, it has been demonstrated that unusually low penetration, together with dilution values ranging from 1 to 10% base metal, can be obtained at normal travel speeds. Appropriate positioning of the welding rods offers control over the depth of penetration and weld shape produced. In addition, a marked increase in the rate of rod deposition and a lower rate of fused melt consumption have been measured. The new series-arc welding technique offers significant advantages in the field of automatic cladding and surfacing with high-alloy and hardenable welding rod composition and for applications requiring rapid deposition of metal.

Another paper, "Multiple Layer

(*Continued on page 11*)



News Digest

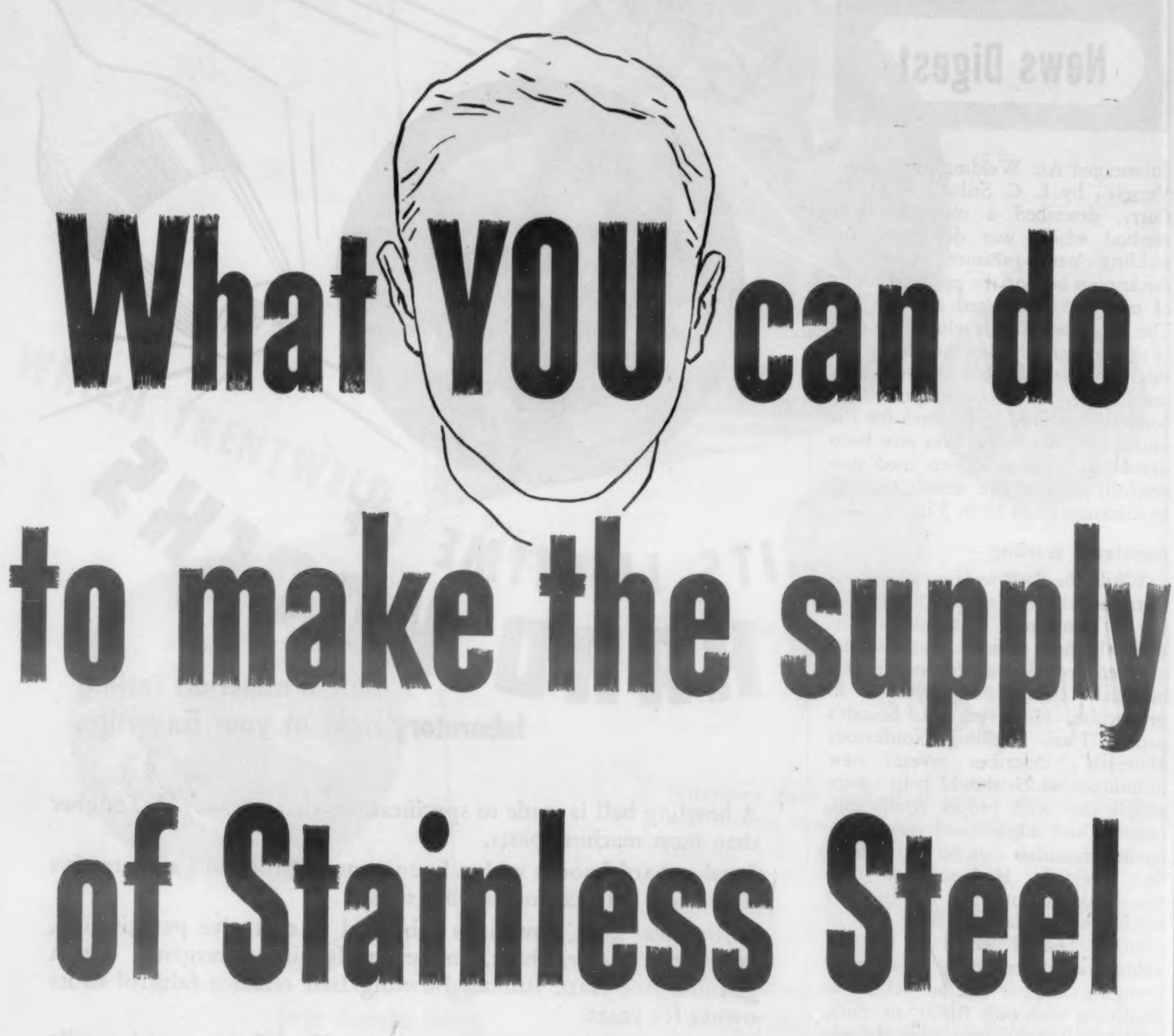
Submerged Arc Welding of Pressure Vessels", by L. C. Stiles and D. H. Curry, described a multiple layer method which was developed for welding steel pressure vessels of thicknesses beyond the practical limits of two-pass submerged arc welding. The procedure was developed because of the excessive repairs required when thick pressure vessels were welded by the conventional two-pass procedure. Joint designs and procedures for the multiple layer method have now been developed and have been used successfully on pressure vessels ranging in thickness from ½ to 3 in.

Resistance Welding

While the flash welding of ferrous metals is relatively simple, flash welding of nonferrous materials is considerably more difficult. For this reason there are relatively few nonferrous materials being flash welded in production. However, F. L. Brandt's paper, "Flash Welding Nonferrous Materials", describes several new techniques which should help assure people that with proper equipment, controls and supervision most nonferrous materials can be successfully flash welded. High-strength heat treated aluminum alloys can be flash welded with relatively little loss in strength. Leaded brasses can be flash welded with acceptable production strengths. Copper can be welded to aluminum with only 0.0005-in. thick weld plus heat-affected zone. In addition, several other nonferrous materials and combinations of materials have been successfully welded and the procedure developed to permit practical application.

Another paper on flash welding, "Optimum Flash Welding Conditions for Aluminum Alloys", by E. F. Nippes, W. F. Savage, P. Patriarca and J. J. McCarthy, dealt specifically with the problems of flash welding aluminum. The results of their investigation indicated that nearly 100% tensile joint efficiency could be attained by flash welding the alloys 61ST, 14ST, 73ST and 24ST. The upset variables were studied, and it was found that the magnitude of the upset current was the most important variable influencing the upset pressure requirements; the temperature distribution during flashing was found to be of significance particularly with the higher strength alloys.

(Continued on page 144)


What YOU can do
to make the supply
of Stainless Steel
go further
USS

UNTIL WE KNOW!

If you want a "yes" or "no" answer right off the bat, please don't ask us whether we can accept your order for metal powder parts . . . for our answer may have to be "No." That's because we delay saying "Yes" until we have satisfied ourselves on two points: (1) Is the part adapted to production by the powder metallurgy process? (2) Will the powder metallurgy process work to the advantage of the customer, in lowered costs or improved performance?

Actually, thousands of parts now made by older methods could be made better or more economically by Moraine. Three simple rules determine whether any particular part meets our standards:

- The shape must permit good die fill and correct density.
- The required physical properties and tolerances must be obtainable by our normal production method.
- The quantity of parts to be manufactured must be sufficient to justify costs of tooling, set-up, and equipment loading.

If we find that your parts pass these three tests, Moraine will be glad to give you a "Yes" answer . . . and to assure you of improved quality and/or lowered costs.

MORAINE PRODUCTS

DIVISION OF GENERAL MOTORS, DAYTON, OHIO

Refractory Cement Selection Made Easy

for ferrous melting furnaces

Type of furnace	metals melted	use of cement	Norton number	cement recommended description	maturing temp.	max. temp.	how applied
indirect arc	alloy iron and malleable iron	lining	RA1144	coarse grain Alundum* cement	2100°F	2950°F	rammed
		patching	RA1160		1850°F		rammed
		troweling around electrodes	RA162	fine grain Alundum cement	1850°F	2950°F	troweled
direct arc	alloy steel and malleable iron	lining roof and around electrodes	RA1144	coarse grain Alundum cement	2100°F	2950°F	rammed
		lining roof and around electrodes	RA1195	very coarse grain Alundum cement	2000°F	3100°F	rammed
		patching	RA1160		1850°F		rammed
high frequency induction	stainless steel and refractory alloys	lining	RM1169	very coarse grain Magnorite* cement	2100°F	3250°F	rammed (dry)
		patching large furnaces	RM868	medium grain Magnorite cement	2200F°	2750°F	rammed
		patching small furnaces	RM1171	medium grain Magnorite cement	2000°F	2900°F	troweled or rammed

for non-ferrous metal-melting furnaces

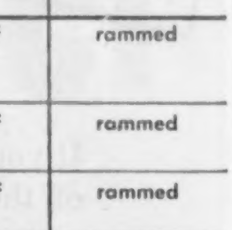
Type of furnace	metals melted	use of cement	Norton number	cement recommended description	maturing temp.	max. temp.	how applied
low frequency induction	refractory alloys, cupronickel, nickel silver, high copper alloys A1, Te, Si bronzes	lining	RM1140	coarse grain Magnorite cement	2300°F	3250°F	rammed
	nickel silver	lining	RA1195	very coarse grain Alundum cement	2000°F.	3100°F	rammed
	brasses not more than 90% copper or less than 10% zinc	lining	RA1144	coarse grain Alundum cement	2100°F	2950°F	rammed
indirect arc	nickel and high nickel alloys	lining	RA1144	coarse grain Alundum cement	2100°F	2950°F	rammed
		patching	RA1160		1850°F		
crucible melting furnaces■	brasses and bronzes	lining and patching	RC1188	coarse grain Crystolon* cement	2000°F	3050°F	rammed
		lining and patching	RC1133	coarse grain Crystolon cement	2100°F	2950°F	rammed
		lining and patching	RC1204	coarse grain Crystolon cement	2000°F	2900°F	rammed
reverberatory furnaces ▼	brasses and bronzes	lining and patching	RC1188	coarse grain Crystolon cement	2000°F	3050°F	rammed
		lining and patching	RC1133	coarse grain Crystolon cement	2100°F	2950°F	rammed
		lining and patching	RC1204	coarse grain Crystolon cement	2000°F	2900°F	rammed

■ Cement not in contact with metal, used in combustion chamber.
▼ Cement in contact with metal. * Trade-marks Reg. U. S. Pat. Off. and Foreign Countries.

This Chart is a synthesis of several charts from a new 16-page bulletin just prepared by Norton refractory engineers, after exhaustive laboratory and field tests.

Titled "Norton Longer Lasting Refractory Cements," this fact-packed bulletin covers the properties, selection and application of the correct cement for your refractory requirements.

Write for Bulletin 863. Norton Company, 340 New Bond Street, Worcester 6, Mass.



NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

Special REFRACTORIES

Canadian Rep. A. P. GREEN FIRE BRICK CO., Ltd. Toronto, Ont.

JOHNSON BRONZE

SLEEVE BEARING DATA

Bearing TYPES

JOHNSON BRONZE

SLEEVE BEARING DATA

Bond Testing of Bi-Metallic Bearing Materials-2

IN Part 1-Bond Testing of Bi-Metallic Bearing Materials we pointed out the importance of securing a definite *bond* between two or more metals in the production of quality bearings. While the only reliable tests available at this time are destructive in nature, they serve as an accurate gauge of quality during the manufacturing process. The test most widely used is the chisel test—Figure I.

If the alloy layer can be detected both on the overlay and the base metal, brittle bond is indicated. If the overlay metal is stripped clean from the base metal, then the bond is bad rather than brittle.

Tables II and III outline rating methods which can be employed to classify the results of the chisel test.

base babbitts containing tin, a bond number of 2 may be obtained. Tin alloys on steel usually have a bond number of 2 while on bronze the bond number may be 3, due to the fact that heavier layers of the brittle tin-copper compound are formed.

The presence of a brittle bond in a composite bearing material is not undesirable as long as the bond strength is high and the bearing is not subjected to heavy fatiguing stresses. Fatigue loads, which are of a cyclical, repetitive nature tend to flex the material back and forth, which flexing induces shear stresses in the bond layer. Brittle bond compounds are usually weak in shear strength, but in some cases, it has been found that material with a bond rating of number 4 will perform

TABLE II

Bond Ductility Rating

Bond Number	Rating	Percent of Overlay Metal Fractured Along Bond Line
1	Good	0- 5
2	Good	5- 15
3	Fair	15- 40
4	Poor	40- 60
5	Bad	60-100
6	Bad	100

TABLE III

Bond Completeness Rating

Bond Number	Rating	Appearance of Chisel Marks
1	0	No tendency of two metals to separate.
2	0- 15	Separation at edge of chisel marks.
3	15- 40	Bond separates in spots.
4	40- 60	About 50% of base metal cleanly exposed.
5	60-100	More than 50% of base metal exposed.
6	100	Base metal completely exposed.

Lead alloys should have a bond number of 1 on steel backs, although with lead

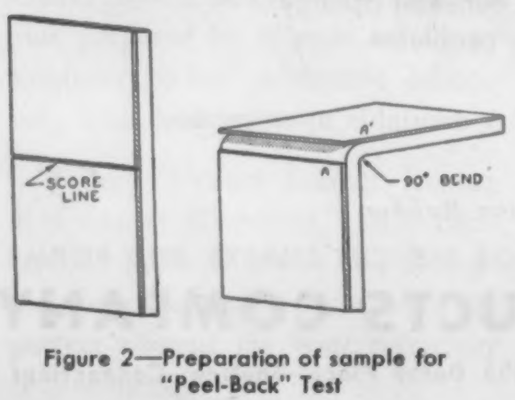


Figure 2—Preparation of sample for "Peel-Back" Test

satisfactorily in bearing applications. This is especially true of material such as bushing stock fabricated by sintering bronze powder on a steel backing. The bonding is not complete due to the natural porous structure of the bearing metal.

Also, the semi-quantitative value of the test does not signify that bond number 2 is faulty and, in many cases, a bond number of 3 is entirely acceptable.

Further interpretation of bond strength by the chisel method is possible with the aid of a "peel-back" test. In this test, the specimen is bent 90 degrees on the backing metal which flexing promotes shear along

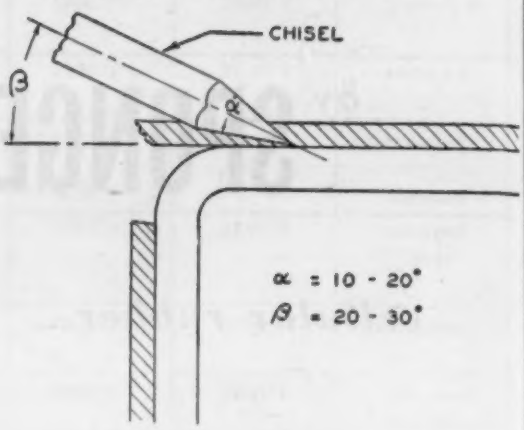


Figure 1—Chisel Test of Bond Bi-Metallic Bearing Materials

the bond line and enables the tester to study the type and quality of the bond more thoroughly.

The "peel-back" test is illustrated in Figure II. The piece to be tested is placed in a special fixture, notched along the bearing surface and bent back over a fixed radius. The stretching action along the arc of the bend causes shear stresses to be set up in the bond layer. If the bond is brtitle or weak, the overlay will tear loose and can be peeled back. The distance A-A' that the metal peels back is one indication of the bond strength and quality. Further interpretation can be made by chiseling into the overlay from point A'.

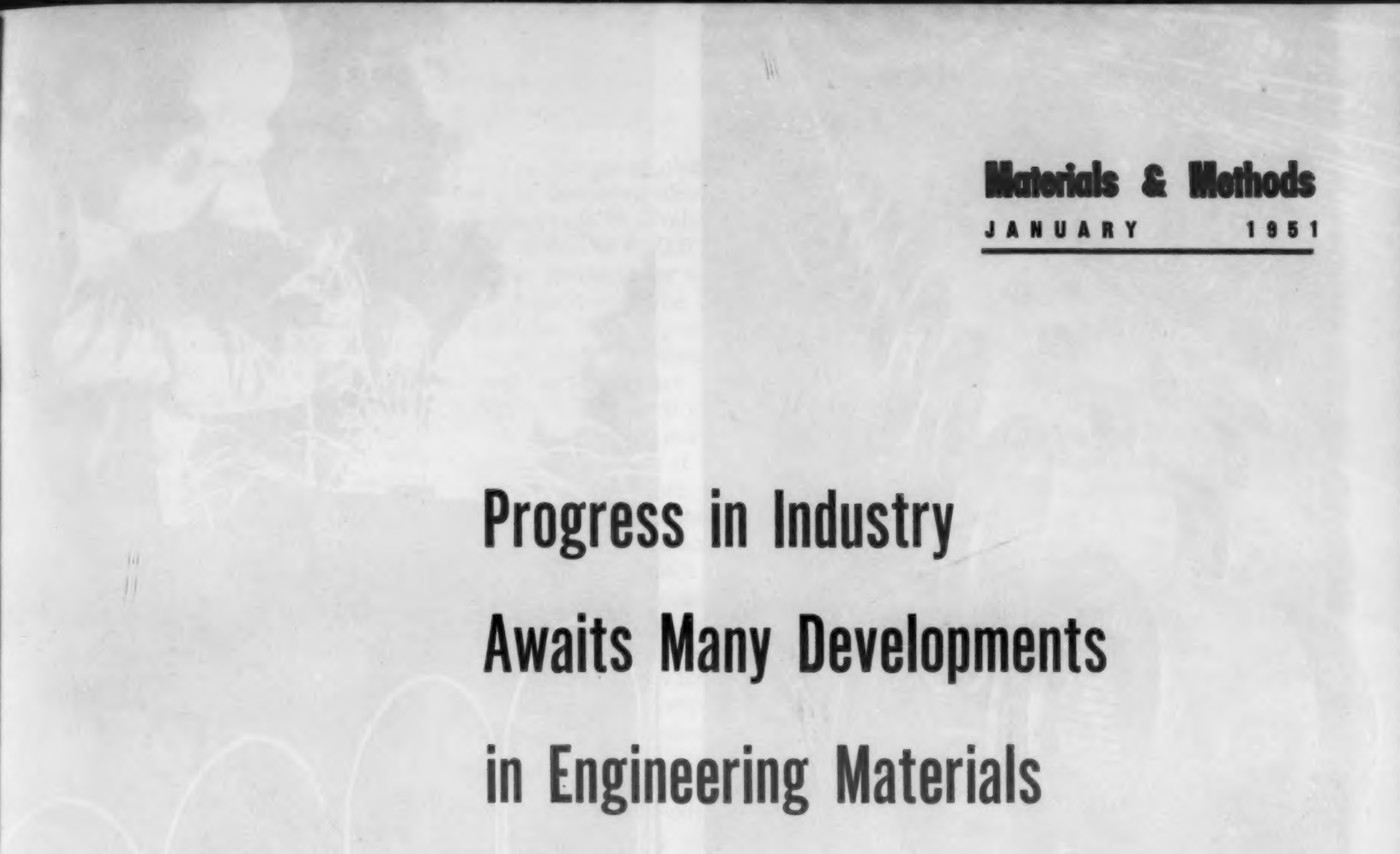
Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
769 S. MILL ST. • NEW CASTLE, PENNA.



Progress in Industry Awaits Many Developments in Engineering Materials

by T. C. DU MOND, Editor, Materials & Methods

Materials that will withstand temperatures above 1600 F, better corrosion resistant materials, and more basic research are the most persistent of industry's needs in engineering materials.

● WAR OR PEACE, industry demands new and better engineering materials to keep pace with technological advances. A war or defense economy speeds research into materials engineering problems by making time more valuable than money and releasing huge funds for research and development. Even in peace time, though, increasing amounts are spent each year in looking for better materials which will eventually make engineering dreams come true.

Despite the thousands of metals, alloys, plastics, ceramics, metallic compounds, rubber compositions and other nonmetallic materials from which to choose, industry always seems to need something just a little better than is now available. The same need holds in materials processing and fabrication despite major improvements made in these fields.

Progress in nearly any field one can call to mind is linked inseparably to improvements in materials. During the first half of this century, progress was spurred by the needs and demands of the automotive and electrical industries. More recently the aviation and process industries have added their weight to the constant pressure for not only better materials and methods, but also more fundamental information about materials. Atomic energy will combine with the latter two fields during the next half century to bring about continued change and improvement.

Well documented is the role of materials engineering in the electrical field. A few months ago engineers of the Westinghouse Electric Corp. reported on changes in their specialties during the first 50 years of the 20th Century. That new and improved materials permitted better and more efficient products is a fact that is inescapable.

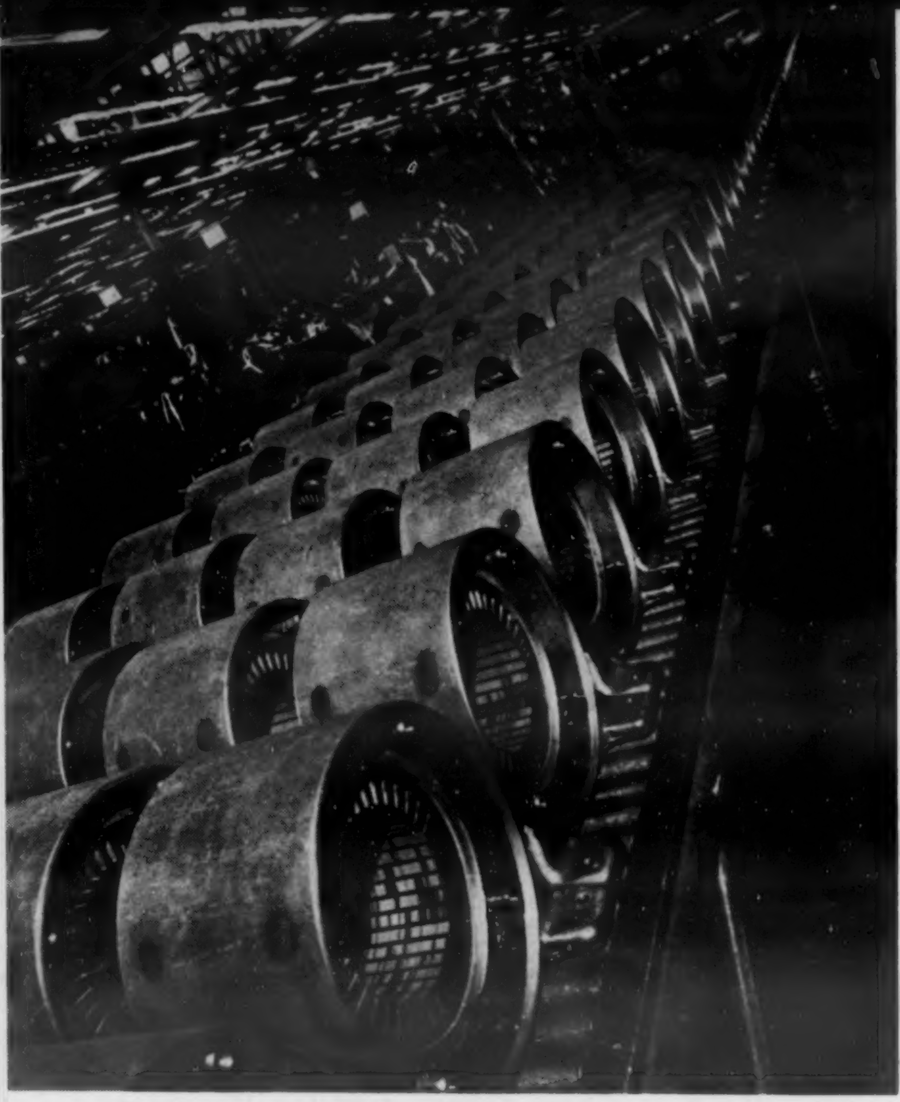
Some specific examples follow:

In steam turbines, higher speeds and pressures have only been limited by the mechanical strength of metals. The available materials of the early years permitted a speed of 400 fps, at mean blade height. Now improved metals allow a speed of 1025 fps. At the outset blades were made of drawn brass, and later either phosphor bronze or 5% nickel was used. Still later came manganese copper and 12% chromium-iron alloys. The latter alloy is still used extensively, and improvements in it are expected to permit higher speeds.

Again examining turbine development, we find that early rotors were built up from relatively small steel forgings and castings assembled with shrink or press fits, supplemented by bolting or shrink bars. Such assemblies were satisfactory at low speeds and low steam temperature. Now, even the largest machines have rotors that are forged in one piece from carbon and alloy-steel.

Iron castings were used for early steam containers, but grain growth at higher temperatures would not permit close fitting parts, so carbon-steel castings came into use as service temperatures increased. These alloys permitted higher steam temperatures, but then the phenomenon of "creep" plagued the engineers. Therefore, it was necessary to recognize and understand creep and to provide alloys to resist it. Study led to the use of more complex alloys containing molybdenum and chromium. At still higher temperatures 18:8 columbium stabilized stainless steel proved satisfactory, but designs had to be changed considerably to take into account a high coefficient of expansion and relatively low heat conductivity.

Gas turbines and jet engines be-



Generators and motors, although changing little in basic principles and design over the past 50 years, have been vastly improved through better engineering based on superior irons, insulations, and manufacturing methods.

With new advances in materials, come new problems in processing and fabricating. One example is the need for better methods of welding molybdenum, vanadium and titanium.

As satisfactory high temperature metals or compounds are developed, there will be the additional need for adequate gasketing materials. Plastic materials have been suggested as a possibility, based upon the possibilities already shown by Teflon. Such materials are useful in applications where corrosive conditions are encountered. Besides having heat resistance, materials for gasketing should also have greater resilience than existing materials.

Corrosion Resistant Materials

The number of commercial and industrial applications which could use materials that would provide greater corrosion resistance than those now available are almost endless. Here again, it does not matter too much whether the answer lies in a base material or in a coating. Economics would decide at some later date as to which would be most practicable.

One engineer cited as an urgent need some economical material capable of withstanding the corrosive effects of concentrated nitric acid (97+%) at temperatures up to the boiling point of the acid. Organic materials that could also be used as containers for nitric acid are also desired. The same or similar materials might also be used to protect personnel handling highly corrosive liquids.

Plastics

It has only been since 1925 that the use of plastics really started in industry. Since that time the various plastics types have come to be essential materials. Now in determining future needs we are made to realize that there are many plastics improvements that would help industry tremendously.

Previously it was indicated that a high temperature gasketing material is wanted with plastics seemingly offering the best possibilities. Several industries, the automotive and aviation among them, would welcome a clear plastic similar to Lucite, Plexiglas or the transparent polystyrenes that will be hard and have no tendency to craze or scratch. To completely meet the needs of the industries mentioned, the plastic also must be heat resistant, tough and readily molded. An immediate use for a plastic meeting the specifications would be for automotive and aircraft windshields and windows.

The shortage of benzene has curtailed production of polystyrenes and, therefore, accentuates the need for another plastic material falling in the same price range. Markets are now awaiting a water-resistant, transparent plastic in this category.

Automobile manufacturers use considerable quantities of plastics now, but the amount would be greatly increased if the complete specifications could be met. To take the waiting market, the plastic, whatever it may be, will have to be available in large quantity, low in price, durable under extreme weather conditions, have long life and be readily formed so as to make large scale production feasible.

Somewhat related to the need for clear, hard plastics is a demand for better glass. Glass at present has too narrow a range of mechanical properties. Automobile producers would welcome a better safety glass for the curved windshields now in vogue. Some method of eliminating the brittleness of glass is needed so that it is less likely to crack and chip. For automotive use, glass with better thermal properties would keep cars from overheating when parked in the sun.

Other engineers are looking for a better method of shaping glass in order that more accurate dimensions could be achieved. Shrinkage which now results when hot formed glass parts cool makes the attainment of close tolerances extremely difficult.

Rubber and Rubberlike Materials

From the inception of the rubber-tired bicycle wheel, there has been an insistent demand for better rubber. Considerable progress has been made, but there is still room for more improvement, primarily along the lines of retaining the rubber's best properties over a much wider temperature range.

Depending upon the proposed uses, engineers are looking for a natural or man-made rubber which retains its properties at anywhere from −40 to −70 F. At the other extreme, properties should be retained at temperatures varying from 200 to 500 F.

One example of an immediate need is to provide a material to seal the lower end of a cylinder liner in a Diesel engine. Among its other properties, the rubber will have to be highly resistant to oil. Here, temperatures can cover a range of from −40 up to 400 F.

Synthetic rubbers have improved on certain properties of natural rubber, but engineers feel that there is a need for more research to develop even better synthetic rubbers. While having many properties that are better, the man-made materials have not yet achieved the high gum strength of the natural products. For certain applications, therefore, such as dipped and foamed articles, natural rubber is still almost irreplaceable.

For the aviation industry the temperature ranges for rubber are even wider than mentioned previously. While seeking even higher top temperatures, a rubber that could retain all of its properties and still resist the action of oil and aviation fuels up to 500 F would be accepted eagerly.

Other Materials Developments

Here are some of the other improvements anticipated or desired:

Cold-rolled sheet steel for generator cores to replace the currently used hot-rolled silicon sheet. Economy in both original cost and in processing could result from this development.

The electrical industry is vitally interested in still further improvement in the silicon-iron now being used for transformer cores. A material to carry twice as much flux with equal or lower losses than existing materials is the goal. Silicon might be replaced by cobalt or some other alloying element. Attempts might be made to rearrange the electrons in the outer orbits of iron atoms to provide desired characteristics.

The design of electrical capacitors would benefit if thinner metal foils were available. Foils now produced are as thin as 0.0002 in., but any decrease in thickness will permit smaller capacitors to be built. A similar need has been expressed for thinner plastic sheet materials which could be used as dielectrics for condensors. Again, size reduction is the goal.

Many existing materials would be used more widely if their costs were lower. Typical are aluminum and magnesium. For instance, under normal conditions the automotive industry would use much greater quantities of these materials if the cost were less. Changes in basic production techniques would probably be the only way in which lower prices could be attained. A comparable situation will confront titanium in the not too distant future. Current prices are much lower than they were two years ago, but the methods used to reduce titanium are too costly to permit prices to drop much further. It is said that a pound of magnesium is used in the production of 1 lb of titanium; therefore, it is hardly likely that the newest structural metal will ever be cheaper than magnesium.

An interminable list of materials improvements could be established, but the list presented thus far is sufficient to keep research staffs, materials engineers and designers busy for many years to come, and to serve our purpose in showing the vastness of our need for more knowledge and more and better materials.

Needs in Fabricating and Processing

Nearly every materials development brings with it new problems in processing, fabricating and treating. Even today, some of our processers have not yet caught up with existing materials.

In one general area of activity alone, there is still room for much improvement. The cleaning and finishing of metals is still uncertain, often difficult, and usually expensive. Nearly every metal fabricating plant has a continuing cleaning problem, particularly when the parts must later be plated or painted. As new drawing compounds come into use, new and better cleaners must be developed.

On products destined to be in service for considerable time, it is common practice to treat all surfaces with phosphate coatings to inhibit corrosion. However, corrosion still does occur, leaving us with the task of finding a simple, low-cost method of preventing rusting.

Also in the finishing line we know that one of the most serious needs, from a cost standpoint, is a finish that can be applied in all colors in one coat directly to the metal. The finish should provide a smooth and shiny surface without buffing.

The elimination of buffing prior to plating for decorative purposes is also hoped for. In many cases, the cost of buffing is about 70% of total plating costs. Many will consider that the acme of achievement will have been reached when plated coatings are completely free of pits and pinholes and will protect the base metals for much longer periods than is now possible.

It would be difficult, indeed, to estimate the amount of money spent each year to find better methods of joining metals to metals, nonmetallics to nonmetallics, and metals to nonmetallics. Recent successes in replacing rivets in attaching linings to shoes on automotive brakes indicate that we might soon have similar adhesives which could be used to assemble many parts of an automobile or other large structure.

Recent years have seen the development and application of cold welding. For the time being, the method is restricted largely to copper and aluminum alloys. Many industries look forward to the day when steels and other hard metals can be joined in the same way.

Users of molybdenum are now looking for better methods of welding it. As the use of this metal as well as that of ductile vanadium, tungsten, zirconium and titanium grow, the joining problems will become more intense.

There have been few improvements in making dies for plastics molding, forging, chill-molding and die casting. Improvements over the existing methods are looked for primarily to reduce die costs, which now are so high as to limit the usefulness of those processes requiring dies.

As with the needs in materials, looked-for improvements in fabricating techniques are also virtually limitless.

Even though an intensive search of industry was not made to uncover a complete list of problems facing researchers and development men, the complex list included here is sufficient to establish the fact that most of our engineering frontiers are still to be faced.

came practicable only after considerable metals research involving such problems as creep-to-rupture and fatigue testing. The result has been the development of at least four turbine blade materials, each better than its predecessor. New high-temperature alloys also were developed for the hot parts of the engines.

A.c. generators in a period of 50 years have not changed in basic form or principle, but improvements have been so vast that in that period there has been a growth in rating of about 60 times. The improvements came about through better engineering based on superior irons and insulations and methods of assembly. Insulation, for example, progressed from simple untreated cloth and paper, through varnished cloth and paper, then to mica insulations, and now to glass fibers. Future insulation developments will be depended upon to permit smaller sizes of units through higher thermal efficiency.

Early stator cores were built-up from soft sheet iron laminations. Next came silicon irons, which were vastly superior. Basically the same material is now used, but closer carbon control, improved melting practice and better annealing methods make the silicon iron immeasurably superior.

Basic research in materials, often neglected, ranks high in industry's present and future needs.

The need for better materials in transformer core materials led to the development of a silicon steel which, during the last war, proved invaluable in electronic apparatus. The material is so made that its crystalline cubes are oriented in the direction of magnetization, thereby giving better flux flow and low losses. In this instance, a superior material made necessary a change in design to take full advantage of the material's properties.

Examples given here are by no means all that could be cited even in the electrical industry. Similar examples could be extracted from the records of other manufacturing industries.

However, our objective is to point out some of the future needs of materials engineers. Many of the needs are immediate, while others in the more distant future can be forecast by the current rate of engineering development.

An informal, and far from complete, survey of industry's needs in engineering materials has established that the two most insistent needs today are for materials that withstand high temperatures and for materials and finishes that are resistant to highly corrosive media. Specific improvements are sought in metals, plastics, rubbers, ceramics and glass.

Statements on materials needs come from a cross-section of United States industry—from representatives of automotive, aviation, communication and chemical processing fields as well as from research groups.

High on this list of needs is one which has been spotlighted in recent weeks due to the demands of military stockpiling and defense production. The need, of course, is to find some means of substituting for critical metals. During World War II, we overcame some of the problems, but we still need more substitutes. The present need is most acute with cobalt, tungsten and columbium. Satisfactory substitutes might survive a war or scarcity period and serve to protect us against diminishing supplies and increasing prices of these metals.

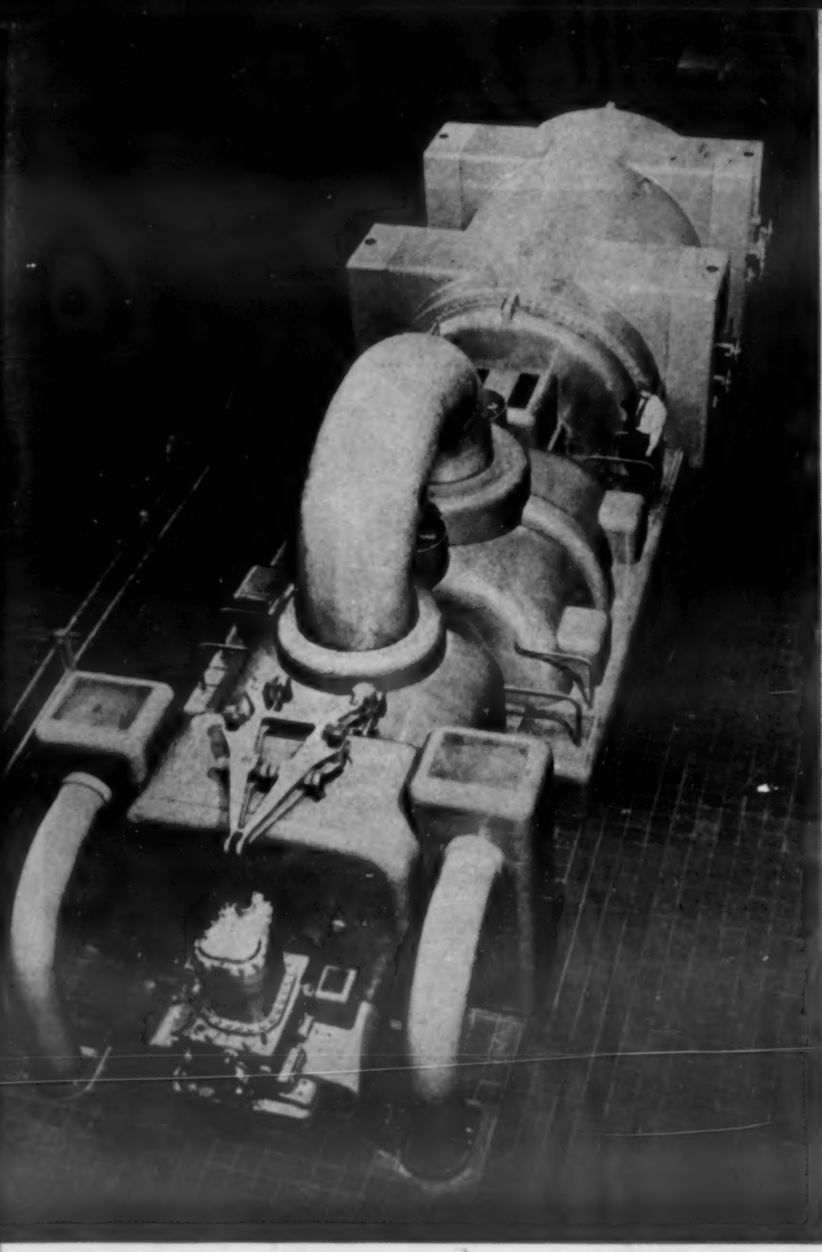
Pure Research Important

Recognizing the fact that all of the hoped for developments mentioned in this article will have to be based on considerable research, there is a strong awareness that more research of a fundamental nature must be completed before progress can be made.

The key to much future progress lies in the answer to the question: "Why do materials behave as they do?" Knowledge of how materials react under specific conditions is well established, but the reasons for the reactions are still mysteries. As an example of the problems, one could consider the question of why steels meeting specifications can vary so widely in properties from lot to lot, even when coming from the same mill.

Probably all materials could be made stronger if we knew exactly what gave them their strength. Research in connection with atomic energy is probing at some of these mysteries, but complete knowledge seems some distance away.

Recently it was learned that if a minute quantity of tellurium is added to malleable iron, annealing time can be cut in half. Likewise, it was discovered that extremely small quantities of boron improved the hardenability of steel. Such discoveries indicate that a whole new field of research could be devoted to learning the effects of small quantities of alloy-



Steam turbines with higher speeds and pressures await development of new high temperature materials. (All photos courtesy Westinghouse Electric Corp.)

Turbojet engines, such as this one, became practical only after considerable metals research. Future advances depend heavily on improvements in engineering materials.

ing elements on materials.

As one automotive research executive has summarized, "We need new and better heat resisting alloys, improved wear properties, better machinability, good corrosion resistance, improved hardenability, all of which must be obtained without increasing costs".

Another specific desire is for more knowledge of the cause and prevention of heat checking in steels.

High Temperature Materials

It is an established fact that the performance of gas turbines is improved by using operating temperatures above 1600 F. Therefore, metals and alloys as well as nonmetallic materials that will withstand temperatures in excess of 1600 F are sought. It matters little if the answer is in the form of solid material or a heat resistant coating that can be applied to existing materials.

In aircraft uses, the material of the future could be one having either a ceramic or metal base. In addition to withstanding temperatures in excess of 1600 F, the material should also resist the action of oxidizing atmospheres. Coatings meeting requirements would work satisfactorily in the range from 1600 to 2500 F and be equivalent in performance, at these temperatures, to enamels, and plated or sprayed-on coatings used at room temperature to inhibit atmospheric corrosion. Some surface coatings now available have adequate mechanical strength and structural stability at required temperatures, but do not have adequate corrosion and erosion resistance.

Temperatures anticipated in the immediate future for steam turbines do not now exceed 1150 F, but even these will require better materials than are now available for blading uses as well as for steam chests and condensors.

In the more distant future, engineers see the possibility of a superturbine utilizing steam at 1200 F and 3206-lb pressure. A turbine of this kind could provide an increase in thermal efficiency of about 8%. However, such a turbine would require a material that is not now known. For example, nozzle chambers would probably have to be cast of the unknown material which would have to withstand both high temperatures and high pressures. Casting is mentioned because operating temperatures are now close to forging temperatures. Rotating elements would also present a problem which might be answered by utilizing gas turbine materials formed into a series of small wheels, rather than using one large rotating stage subject to extremely high centrifugal forces.

One answer to several of the problems already enumerated might be found in the development of a ceramic material having a coefficient of expansion approaching that of metals. A material of this nature could find much use in many fields where heat and various types of corrosion are encountered. At present several groups are experimenting with ceramic combinations and might be close to having the answer.

In commenting on the need for high-temperature metals, one correspondent remarked that "There seems to be a definite need for better understanding the fundamentals of metals at high temperatures. Closely allied to the development of high-temperature metals are the problems of design and fabrication for those metals which might be developed."

Alternate Steels Useful as Substitutes for Critical Materials

by EDWIN LAIRD CADY

Although steel production is at an all-time high, unprecedented defense demands will require use of many steel grades having minimum alloy content. (Courtesy Bethlehem Steel Co.)

With the defense effort rapidly expanding, the leaner NE steels (now called Tentative Standard steels) are again proving valuable as replacements for scarce alloy grades.

• IF YOU ARE a manufacturer of non-essential products, it is not too soon to consider substitutes for scarce or critical materials. Already, many segments of industry are unostentatiously and efficiently going on voluntary allocation much more rapidly than the government is forcing them to. For example, in the steel industry, even before the nickel order was issued by the NPA aimed at reducing the use of critically short nickel, steel warehouses and large users reported, in "off the record" interviews, that high nickel alloys are very difficult to obtain unless the buyer can show a D.O. (Defense Order). They wanted to make sure that the nickel was going where it was most needed. Others are doing the same thing with the unrestricted portion of the available copper alloys, aluminum alloys, plastics and other materials which sometimes can substitute for nickel steels. Clearly, under such conditions the steel user has no choice but to go to the leaner steels, known as NE (National Emergency) steels during the last war.

The government is not idle in the matter. On Oct. 12, 1950, it issued M-1 Title 32A National Defense Appendix. In this the steel mills cannot be required, unless specifically directed to do so by the National Production Authority, to accept Defense Orders in excess of specific percentages of average monthly shipments, the percentages being applicable to the base period of Jan. 1, 1950 through Aug. 31, 1950.

On its face, Title 32A does not seem unduly burdensome. D.O. percentages run from 5 to 25%, with most of the most-used products happily in the lower percentage ranges. But there is a paragraph which states that if anyone in defense work needs to buy D.O. steel and cannot find it, he can apply to the National Production Authority for help in finding it. Therefore, a supplier who then is asked to supply steel beyond his D.O. percentage can protest to the NPA: (a) that the requested increase works hardship on him not shared generally by others in his industry, or (b) that enforcement against him is not in the interest of national defense. Of course, the chances of a mill refusing the extra business if it can handle it are remote. Nevertheless, the user who is not on a D.O. basis must gamble on the percentages of mill capacity which are not thus assigned. Already, as has been stated, the D.O. percentages have resulted in general shortages of nickel alloy steels. Without any direct government order having required it, the "official" sign has been placed on the need to use leaner steels.

Development of NE Steels

When a war shortage of alloy steels occurred in 1942, the steel industry, under the leadership of the American Iron and Steel Institute, evolved the NE (National Emergency) steels. The name "National Emergency" was psychologically good for the war-time period, not so good for the peace-time.

Men highly placed in the alloy steel industry feel that the NE steels deserved a higher percentage than they received of the peace-time market, and that if they had obtained it the present shortages would not have been so acute nor would so many steel users be faced with the necessity of making alloy changes at a time when heat treating and other equipment for the leaner alloys is so difficult to obtain. Therefore, the NE steels, or their substitutes, are to be renamed. The present name is "Tentative Standard". A better one probably will be thought up.

The actual post-war situation seems to have been:

1. The NE steels held about 15% of the post-war market.
2. Much of the market they should have held was lost because men feared the implications of the word "Emergency".
3. Some of the market was lost because emergency steels are not "glamour" steels, the glamour being helpful in advertising.
4. Some fabricators lacked the equipment, the will or the know-how to heat treat the NE steels for the results they needed. A generally cited figure is that while NE steel might need a temperature held within ±100 F, a high nickel alloy might heat treat successfully even if the temperature went off 200 F.
5. There was, is, and always will be, a large market for which the higher alloy steels can find no alternate materials.

Just how much of the market the leaner steels might have held if factors 2, 3 and 4 had been absent from the picture, no one knows. But it almost certainly would have been big enough to prevent us from going into a war economy with our supplies of some of the alloying materials already over stressed by the consumer product demand.

Tentative Standard Alternate Steels

At the present moment some 150 larger makers and users of alloy steels are using all, or some, of the following alternates. The selection is based on hardenability comparisons only. There is no formal agreement on the alternates. Different authorities have arrived at the same points in regard to their values.

Standard Steel Series	*Tentative Standard Alternates*
1300	8600
2300	8600 (to 2330 inclusive) 8700 8600 plus 5 points carbon (for 2335 and higher). Note: for low temperature applications, consider the possibility of using a heat treated product.
2500	9300 (except for low temperature and corrosive condition applications).
3100	8600 (to 3130 inclusive). 8700 8600 plus 5 points carbon (for 3135 and higher).
3300	9300
4000	9700
4100	8600 (to 4130 inclusive). 8700 plus 5 points carbon (for 4132 and higher)
4300	No generally applicable alternate
4600	8600 (for bearings RBEC 4700 may be necessary)
4800	No generally applicable alternate
5000	Special low alloy
5100	8600
52100	No generally applicable alternate
6100	8600
8600	No change
8700	No change
9200	8600
9300	No change
9400	8600
9700	No change
9800	No change

To the tentative standard alternates given above, two additional steels have been added, as of October 1950:

TS 4012, a chromium-molybdenum-manganese steel of carburizing grade which is an alternative for some of the special high alloy steels.

TS 4720. This is the former RBEC (Roller Bearings Engineering Committee) 4720 which was used somewhat during the war, mostly abandoned in the post-war, but is believed to deserve extensive peace-time use as well as being a necessity for some uses under present conditions.

The exact development of leaner steels of Tentative Standard types awaits further studies by the steel industry, and also awaits the developments in the present steel procurement markets.

The feeling is general that ingenuity has by no means been exhausted in the changing of designs or of fabricating methods in order to employ higher carbon contents and thus reduce alloy contents.

The use of higher carbon to reduce alloy may bring problems of welding and of corrosion resistance. But we now know more about stress analysis and about design for proper stress distribution than we ever did. Higher carbon steels readily lend themselves to selective area or selective depth heat treatments to obtain different wear and mechanical properties in accordance with stress analyses. We have more induction heating, salt bath, furnace and other equipment suitable for selective area hardening. And we have more knowledge of how to use the equipment.

With proper design and fabricating methods, Tentative Standard steels can successfully replace higher alloy steels in many applications. (Courtesy Inland Steel Co.)

Brazing in Salt Baths Offers Production Economies

by JOHN B. CAMPBELL, Associate Editor, Materials & Methods

The rapid and uniform heating provided by salt baths suits them for brazing of both simple and complex assemblies, and for both large and small-scale production.

• BRAZING HAS LONG BEEN a standard method of joining component parts. Recognized production techniques include torch brazing, furnace brazing and induction brazing. To these must now be added still another useful technique—salt bath brazing.

Pioneered some years ago by Ajax Electric Co., salt bath brazing makes use of molten salts as the heating medium. Assembled components, with brazing alloy inserted at the proper positions, are immersed in a molten salt bath which is maintained at the brazing temperature. After the brazing alloy has melted and flowed into all joints—usually a matter of seconds—the assembly is removed from the bath and cooled. The brazing alloy, of course, solidifies immediately when the assembly is removed.

Any material, ferrous or nonferrous, that can be brazed can be brazed in a salt bath furnace. Furthermore, any type of bonding alloy can be used —including silver solders and copper, brass and aluminum brazing alloys. The salt baths used for silver soldering, copper brazing and brass brazing consist of mixtures of barium, sodium and potassium chlorides. The bath used for aluminum brazing is a special fluoride flux bath.

The factors which normally influence joint design and the form and location of the brazing alloy are the same for salt bath brazing as for older procedures. Clearances are also the same, ranging from 0.001 to 0.003 in. Although there is no change in the cleaning procedures required before brazing, the problem of cleaning after the brazing operation is simplified by the salt bath process.

Rapid and uniform heating, characteristic of salt bath operations, has resulted in the application of this brazing process to both simple and complex assemblies, and for both large and small-scale production. Now, several years of operating experience make it possible to evaluate fully the advantages and limitations of salt bath brazing and to indicate rather clearly the types of applications for which it appears most suitable.

Process Advantages

Salt bath brazing has been found to offer certain inherent advantages which can be summarized as follows:

1. Temperature can be held within ±5 F of the desired level uniformly throughout the bath. Thus, distortion of the immersed assembly caused by non-uniform heating is avoided.

2. Metal parts can be heated four to six times faster in a salt bath than in a radiation-type furnace, as heat transfer is by conduction only. Immersion times in salt bath brazing are seldom more than 2 min, and even this figure usually includes a considerable factor of safety.

3. A large number of assemblies can be brazed in one batch. The only limits here are the size of the salt bath furnace and the extent to which bath temperature can be allowed to drop when cold metal is added.

4. Because of the high heating rates, selective heating of assemblies is possible. Thus, an assembly can be immersed just far enough to cover the braze joint and removed from the bath before the rest of the metal becomes hot.

5. During the actual brazing step, the metal is protected from scaling and decarburization by the molten salt which envelops it.

6. During cooling, the metal is protected from scaling and decarburization by a thin film of salt which adheres to the surface until it is dissolved off in the quench or rinse. Therefore, assemblies can be either cooled in air or quenched in water directly from the salt bath; neither cooling chambers nor hydrogen atmospheres are required.

7. Joints to which the molten salt is fairly accessible require no flux, as the salt bath incorporates its own fluxing action. In many cases, then, the problem of flux application and subsequent removal is eliminated.

8. Carburizing and various heat treatments can be performed simultaneously with the brazing operation. Where carburizing is to be combined with brazing, the activated cyanide salt bath commonly used for carburizing comprises the heating medium.

Process Limitations

Like any process, salt bath brazing has limitations which tend to make it unsuitable for certain applications. These limitations are discussed briefly below.

1. Salt bath brazing is economical primarily for production work where the equipment is in daily operation. This is because the bath, when not in use, must either be kept molten continuously or shut down and remelted later; either course involves

considerable power expense. In some cases, however, other economies offered by salt bath brazing more than make up for such losses, and this generalization does not hold.

2. Buoyant parts are difficult to handle in a salt bath as they may not remain in the position required for proper brazing. This difficulty can sometimes be eliminated by design changes.

3. Blind joints, which hinder the drainage of molten salt, should also be avoided and can sometimes be eliminated by design changes.

In addition, it should be emphasized that no one salt bath can be used for all types of brazing. This is due to the width of the temperature ranges for brazing. Silver soldering, copper brazing and brass brazing each require a different mixture of chlorides and, as was mentioned previously, aluminum brazing requires an entirely different bath consisting of fluorides. Since economical brazing temperatures, except in the case of aluminum, are about 150 F above the melting point of the brazing alloy, bath temperature must be adjusted whenever a different alloy is used.

Aluminum Brazing Precautions

The salt bath technique has been applied widely to the brazing of aluminum alloy assemblies. However, there are certain precautions which are peculiar to aluminum brazing, and these must be observed carefully for successful operation.

Most important is the precise temperature control required. The difference between the melting points of most aluminum alloys and those of corresponding brazing alloys is quite small and the bath temperature, of course, must be held between those two temperatures. Temperature variations caused by non-uniform thickness of sections can be minimized by preheating the assembly to 900 to 1000 F before immersing it in the bath.

In addition, the problem of bath contamination is more critical in aluminum brazing. If supporting fixtures must be used for aluminum assemblies, they should preferably be designed so as not to contact the molten salt. Otherwise, these fixtures should be fabricated from materials such as nickel, monel or pure aluminum to avoid iron contamination of the bath.

Metallic impurities and moisture must be removed from the bath by means of aluminum rectification or salt additions. Discoloration of the product is evidence of the presence of metallic impurities, and the presence of moisture is revealed by small orange-colored jets of burning hydrogen above the bath.

Brass Brazing

Although copper brazing is more widely used for steel assemblies, research done by Ajax Electric Co. seems to indicate that brass brazing offers many advantages over copper brazing in the salt bath process. Brass brazing can be performed at 1700 F instead of the 2050 F temperature required for copper, which means that the steel is less subject to grain growth, distortion and decarburization resulting from high temperatures. The lower temperature, of course, makes the process more economical. Theoretically, time cycles must be longer at lower temperatures, but actually the difference in this case is insignificant compared to the normal factor of safety allowed in production operations. Furthermore, joints obtained with a 60-40 brass brazing alloy appear to be just as strong as copper-brazed joints for most assemblies.

It is likely that the main reason why brass brazing has not been used to a greater extent in furnace brazing is that dezincification occurs with resulting porosity in the bond and corrosion of furnace elements by the zinc vapor. In the salt bath process, short immersion times eliminate this drawback.

A brass-brazed assembly is illustrated in Fig 1. This auto foot pedal consists of two stampings of hot-rolled, low-carbon steel—a lever and a curved foot pad—which are held together by two rivets prior to the brazing operation. This assembly was previously copper brazed at 2050 F in a furnace and cooled in special chambers. Now it is immersed with

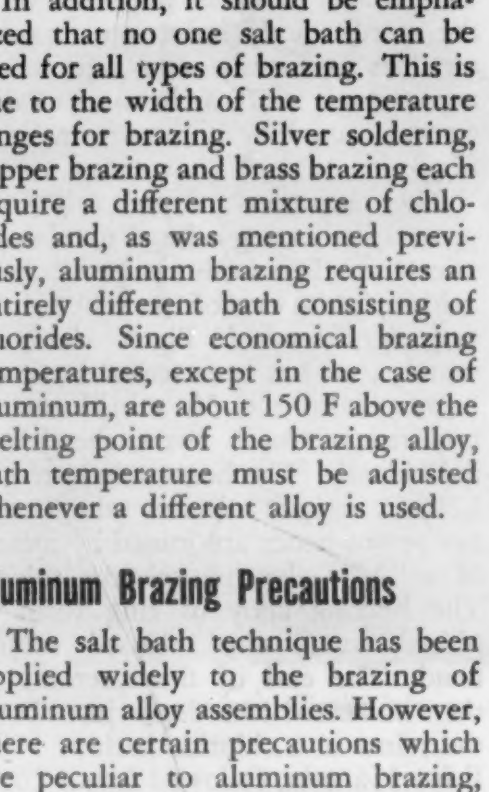


Fig 1—Formerly furnace copper brazed, this steel foot pedal is now brass brazed in a salt bath. (All photos courtesy Ajax Electric Co.)

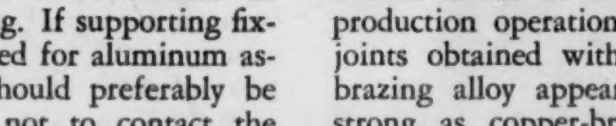


Fig 2—In this exploded view of the steel motor starter, the two sub-assemblies on the left have been simultaneously brass brazed and carburized in a salt bath, while the other part has been simply brazed in the same bath.

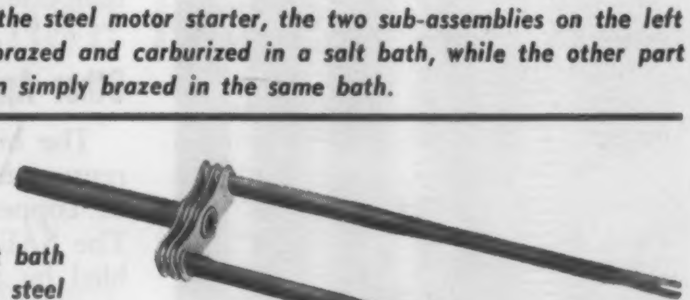


Fig 3—Copper brazing in a salt bath has replaced welding on this steel bicycle fork.

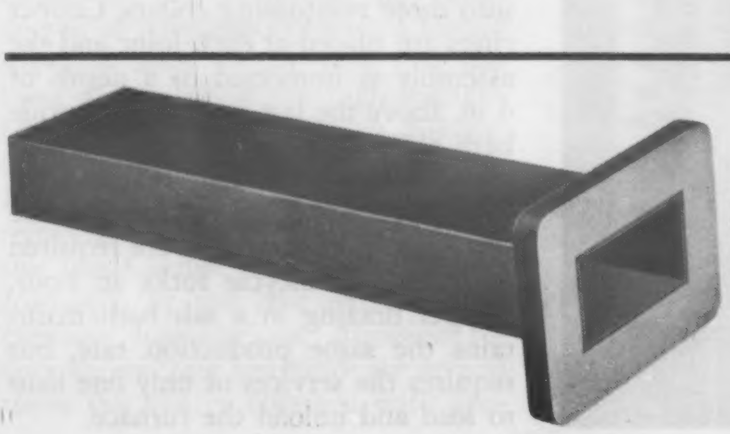


Fig 4—A previously high reject rate was eliminated when this wave guide was soldered in a salt bath.

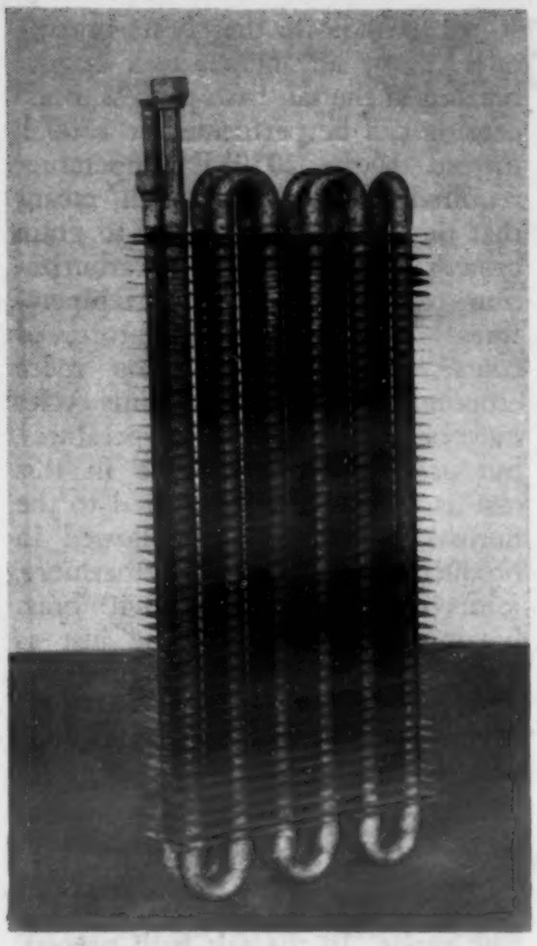
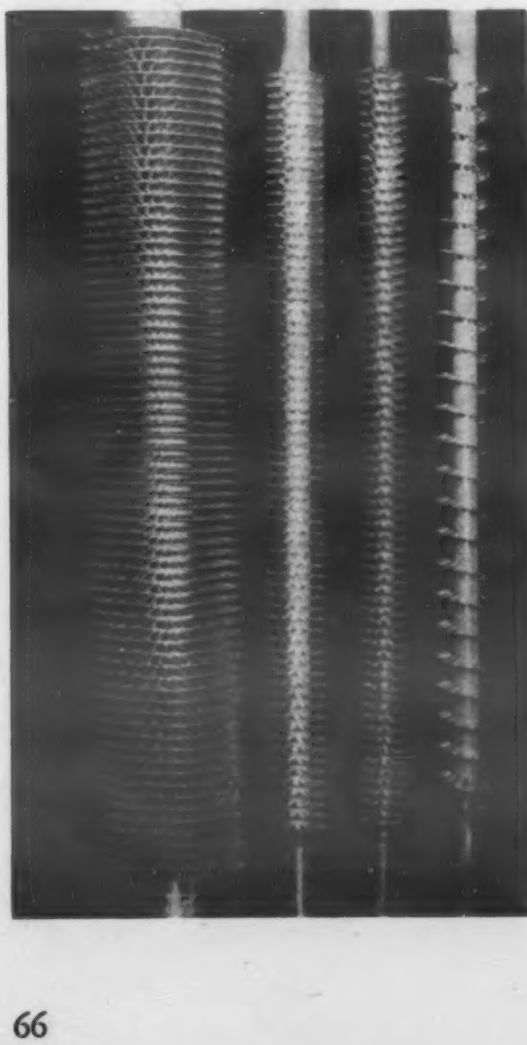


Fig 5—The return bends of this copper heat exchanger are attached by immersing each end of the assembly in a salt bath and silver soldering 12 joints simultaneously.

Fig 6—For some aluminum assemblies similar to those pictured here, salt bath brazing appears to be the only feasible way of attaching the fins to the heat exchanger tubes.



60-40 brass brazing alloy in a chloride salt bath at 1700 F for 1 min, air cooled to 1500 F in about 12 sec, and water quenched.

Since carburizing is ordinarily carried out at 1700 F, it is clear that only brass brazing can be combined with carburizing in the same salt bath. This combination of brass brazing and carburizing, with its obvious economies, is being applied to an increasing number of steel assemblies.

One such application is the motor starter shown in Fig 2. The starter is composed of three sub-assemblies, each consisting of parts made from tubing, stampings and screw-machine parts of SAE 1030 steel. The long tube with the stamped washer and screw-machine part is simply brazed, while the other sub-assemblies are held in the cyanide bath for the 65 min required to produce the carburized case. The long tube assembly is held in the same bath for only 10 min—just enough time to assure a satisfactory braze. The parts are then water quenched directly from the bath without distortion, and after washing have a clean, silvery surface.

Previously, the brazing and carburizing operations on this starter assembly were performed in two separate furnaces equipped with cooling chambers. Now a relatively small salt bath furnace turns out 270 complete starters each hour saving both floor space and production time. Such combination treatments are not confined to carburizing alone; salt bath brazing can also be combined with heating operations in ordinary quench-hardening, as well as in martempering and austempering.

Other Applications

The bicycle fork shown in Fig 3 represents the more common practice of copper brazing steel assemblies. The SAE 1010 parts are pre-assembled by press fitting the stem tube into the cast crown and press fitting the crown and the tubular fork sides into three reinforcing collars. Copper rings are placed at each joint and the assembly is immersed to a depth of 4 in. above the last joint in a chloride bath at 2050 F for 2 min. It is then air cooled to about 1500 F in 15 sec and water quenched. Formerly, the services of five welders were required to make 180 bicycle forks an hour. Copper brazing in a salt bath maintains the same production rate, but requires the services of only one man to load and unload the furnace.

A good example of selective heating is provided by the electronic wave guide shown in Fig 4. This assembly is made by silver soldering a Type 303 stainless steel flange to a brass channel; the parts are held in alignment by two parallel pins which are later machined off. A 50% silver alloy is placed on the upper side of the flange joint. The flange end of the assembly is then immersed about 2 in. in a chloride bath at 1350 F for 1½ min, air cooled to about 500 F, and water quenched. The resulting assembly easily meets the 0.001-in. dimensional tolerance required. With the torch and induction brazing methods previously used, rejects had run as high as 70% because of distortion caused by non-uniform heating.

The usefulness of the salt bath process in brazing a large number of joints simultaneously is particularly evident in the case of the copper heat exchanger shown in Fig 5. Here, assembly time has been reduced to only 2 min from the 30 min formerly required to torch braze the joints individually. The heat exchanger has 12½-in. copper tubes to which copper return bends are joined by means of a 15% silver-phosphorus solder. The brazing alloy in ring form is placed inside the recessed return bend. The end of the assembly is then immersed to a depth just above the joints in a chloride bath at 1500 F for 1¼ min, followed by air cooling to room temperature.

The aluminum heat exchanger elements (shown in Fig 6), consisting of fins bonded to long tubes, are typical of a great many complex assemblies joined by salt bath brazing. In fact, some of these jobs could not be handled satisfactorily in any other way. An assembly similar to those illustrated is first preheated to about 1000 F in an atmosphere-type furnace; this operation requires 5 to 10 min. The assembly is then immersed in the fluoride flux bath at 1140 F for 2 to 3 min. Upon removal, it is air cooled about 30 sec, warm water quenched, passivated in hot 10% nitric acid for 5 to 15 min, and washed in cold water.

From the examples cited above, it is evident that salt bath brazing has proved advantageous in a wide range of industrial applications. In view of the increasing emphasis on speed and economy in production, it seems reasonable to expect that this process will assume an even more important place in the joining picture within the next few years.

Boots molded of the new silicone increase reliability and prevent corrosion of this limit control made by Exhibit Supply Co. (Courtesy Vultee Aircraft Corp.)

New Silicone Elastomer Retains Properties Over Wide Temperature Range

A NEW MATERIALS PREVIEW

Best characteristics of several special-purpose formulations are combined in this new silicone.

• PERFORMANCE IN MANY aircraft applications has established the usefulness of a new silicone elastomer in which a remarkable combination of properties has been incorporated. Developed by Dow Corning Corp., and designated Silastic 250, it equals in elongation the best values that have been obtained to date in silicone formulations, and combines this high degree of stretchability with a tensile strength equal to the best that has been obtainable in the high-strength formulations. In addition to this unusual combination, it performs satisfactorily over a wider range of temperatures, both above and below the usual range, equalling the performance of the best extreme-temperature formulations. Abrasion resistance and tear resistance are several times the figures obtained with general-purpose silicone stocks.

The newest of the silicone elastomers is orange-yellow in color, and has an unusually low specific gravity, 1.2, which will give it a slight advantage in this respect over other silicones when figuring pieces per pound. It is cured at a temperature of 480 F, the length of cure affecting strength properties. Typical properties developed in the cured material are given in the accompanying table.

Like other silicone elastomers, the new rubberlike material can be extruded, molded, calendered or sheeted.

Difficulties in curing limit the thickness of section that can be formed by usual molding methods. Working of the material may require slight variations from standard practice to obtain best results. While the service range of the material is given as -100 F to 500 F, the elastomer has been used where short-time exposures of 600 to 700 F have been encountered, and one user has reported that the material has not failed when exposed to 1000 F for very brief periods.

In general, then, the new silicone combines the best properties of several kinds of special-purpose formulations. Dielectric strength is good enough to encourage users of insulators to consider it as a possible high-temperature covering for wire. Tensile strength at room temperature, tear resistance and abrasion resistance are all lower than the corresponding properties for natural or synthetic rubbers within the range of temperatures at which those rubbers are usable.

Resistance to hydrocarbon solvents, such as gasoline, toluene and xylene, is poor because swelling of the silicone takes place during contact with the hydrocarbon. After the hydrocarbon solvent is evaporated, however, the material returns to nearly its original state and properties. Contact with steam under pressure effects a permanent deterioration in silicone rubber, and should be avoided.

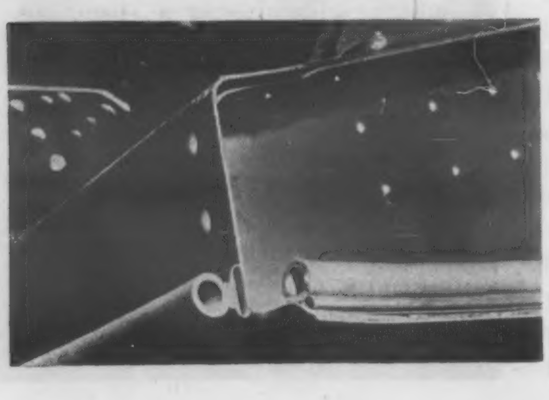
As with all the silicones, price is high in comparison with natural rubber or synthetic rubbers of organic type, but the field of usefulness for the silicone rubber will be in that temperature range where the other elastomers do not perform satisfactorily, so that they are not competitive.

Maintenance of flexibility and strength under extremes of temperature beyond that at which any other elastomer will perform have been the properties that have given the new silicone its present applications. Aircraft duct seals, especially those for the new jet engines, are required to withstand temperatures ranging from about -90 F to about 450 F, while maintaining flexibility and strength, and for such service extreme temperature silicones are the only materials available. Gaskets to withstand hot oil, and temperatures of about 450 F are made of silicones. Bomb bay door seals, boots protecting electrical instruments, housing seals, etc., are using the new elastomer.

Typical Properties of Silastic 250

Property	4-Hr Cure	24-Hr Cure
Tensile Strength, Psi	500-600	600-700
Elongation, %	350	300
Hardness, Shore, A-Scale	35-50	40-55
Compression Set, % (ASTM, Method B, Measured at 300 F)	90	60
Brittle Point, F	−130	−130
Tear Resistance, Lb per In.	60	80
Total Shrinkage, %	4-6	5-7
Dielectric Strength, V per Mil	700-900	700-900
Dielectric Constant		
at 100 Cycles per Sec	3.1	3.1
at 1,000,000 Cycles per Sec	3.0	3.0
Power Factor, %		
at 100 Cycles per Sec	0.2	0.2
at 1,000,000 Cycles per Sec	0.8	0.8

Extrusions of Silastic 250 are used to seal bomb bay doors on the long-range B36 bomber. (Courtesy Vultee Aircraft Corp.)



Silastic 250 gaskets used in this lamp help the base to remain cool, thus extending life of the bulb. (Courtesy Mattox Machine Co.)

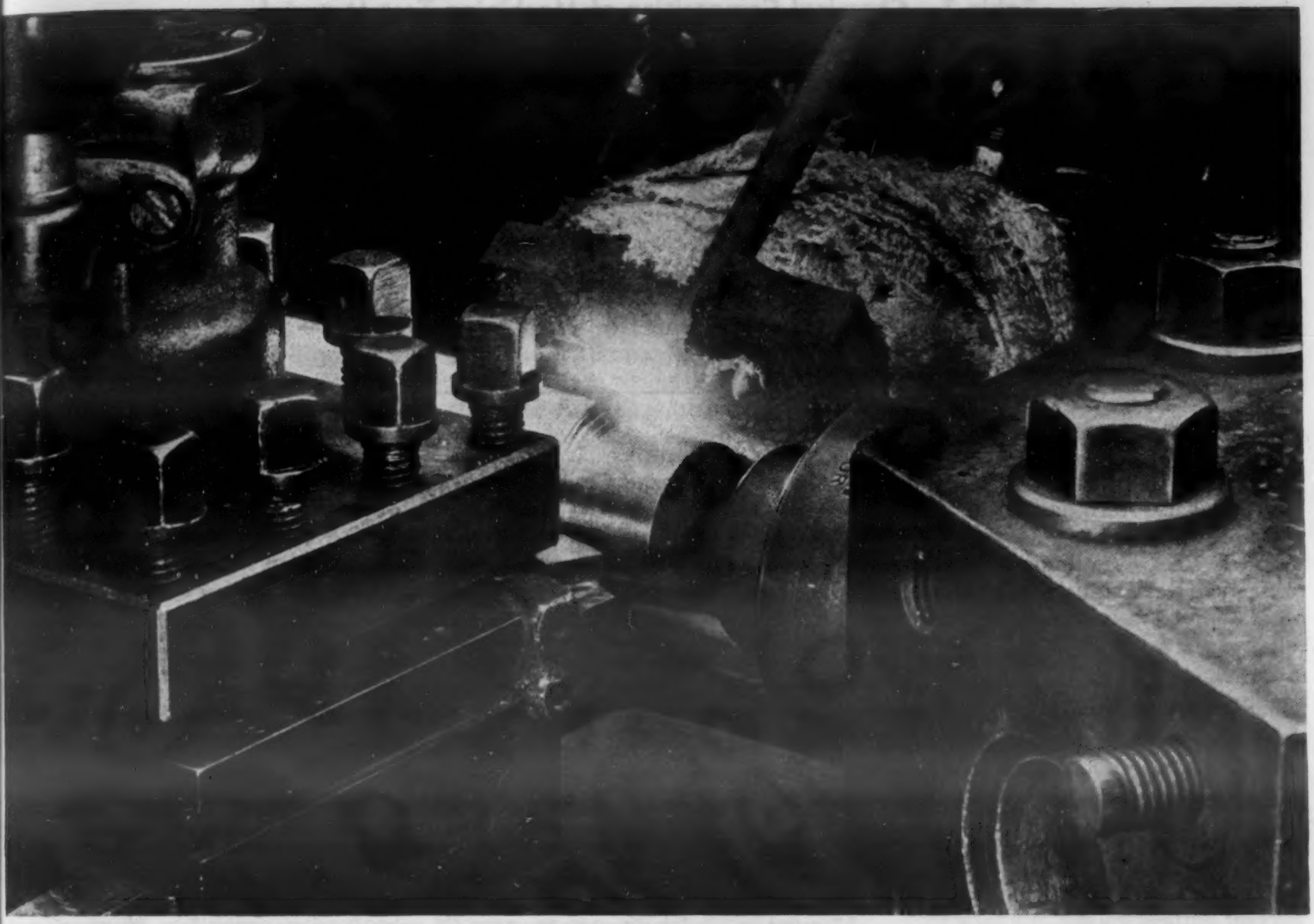


Fig 1—An arc formed between the workpiece and a carbon electrode provides the power density necessary for successful hot machining.

Hot Machining of Many Metals Improved by Arc Heating

by E. T. ARMSTRONG and A. S. GOSLER, Battelle Memorial Institute

Metal cutting at elevated temperatures using new arc heating method has resulted in improved machinability, longer tool life, and the machining of metals previously difficult to machine.

• ALTHOUGH IT HAS long been the accepted practice in machining to use coolants on the cutting tool and workpiece, recent experiments have established the fact that the machinability of many metals is greatly improved at elevated temperatures.

The possible advantages of machining a heated workpiece were suggested by a Battelle Memorial Institute staff member early in 1944 on the basis of two anticipated effects—the relative weakening of the work material at high temperatures, and the fact that metastable transformations, with subsequent hardening, might be avoided by hot machining.

Several relatively crude machining tests were made, using work material heated with a welding torch. The results so conclusively demonstrated the feasibility of hot machining that Warner & Swasey Co. decided to sponsor further developments in the

Table 1—Chemical Composition of Machining Test Materials

Material	Composition, %												
	C	Mn	Ni	Cr	Mo	Si	P	S	Co	W	Cb	Fe	Va
Stainless Steel (Type 304)	0.08	0.29	9.50	20.0	—	0.33	0.019	0.009	—	—	—	Bal	—
NE 8949	0.48	1.20	0.50	0.50	0.35	0.27	0.04	0.04	—	—	—	Bal	—
Clarite	0.72	0.25	—	4.0	—	—	—	—	—	18.0	—	Bal	1.25
Vitallium	0.22-0.25	—	—	25.0	5.5-6.0	—	—	—	Bal	—	—	—	—
NR-76	0.40	—	20.0	20.0	4.0	—	—	—	45.0	4.0	4.0	6.0	—
NR-74	0.45	—	20.0	20.0	4.0	—	—	—	20.0	4.0	4.0	Bal	—

new process.

Preliminary turning tests were made on such metals as type 304 stainless steel, Vitallium, austenitic manganese steel, high-speed steels and high temperature alloys with the following results.

Results on Various Alloys

Type 304 stainless steel. This strong and tough material, which work hardens as it is deformed during machining, is machinable at room temperature. For this reason it provided a simple reference condition, since most of the other materials studied were virtually unmachinable at ordinary temperatures. As was expected, hot machining resulted in a significant improvement in machinability and a greatly increased tool life. Turning tests at various temperatures yielded the tool life-cutting speed data shown in Fig 2, which indicates that an optimum machining temperature exists at which maximum tool life is attained under given machining conditions. At a temperature of 400 F in this particular test, the tool life reaches a maximum which is nearly ten times that attained in conventional machining at room temperature. But even more surprising were the improvements observed in tests of materials which are essentially unmachinable at room temperature.

Vitallium. Because of the difficulty in machining this cobalt-base, high temperature alloy by conventional methods, gas-turbine blades made of Vitallium are usually cast to size to eliminate all possible machining. In fact, grinding is often preferred to very low turning speeds in finishing this alloy. In hot turning tests at 2000 F, however, Vitallium machined freely, forming long, curling chips. The machined surface was smooth and uniform, and satisfactory tool life was achieved.

Table 2—Sintered Carbide Tool Materials for Use in Hot Machining

Conventional Application	% Composition			Vickers Hardness	Tool Life, Min[1]
	WC	TiC	Co		
General Finishing	84	10	6	1690	13.5
High-Speed Finishing	76	16	8	1670	17.1
Low-Shock Finishing	67	25	8	1690	22.0
General Purpose	—	—	—	1470	9.0
Roughing	—	—	—	1480	4.4
Light Roughing	—	—	—	1560	6.6
Finishing	—	—	—	1720	11.5

[1] *Tests run at 700 F workpiece temperature at 400 surface ft per min cutting Type 304 stainless steel with zero rake-angle tools.*

In contrast, when turning was done at room temperature, powdery chips were formed, the work surface was glazed and rough, and tool life was short. These extremes in machining characteristics are shown in Fig 3, which demonstrates the pronounced difference in chip structure, and Fig 4, which shows the improved surface finish resulting from hot turning.

Austenitic Manganese Steel. At room temperature, austenitic manganese steel consists of metastable austenite, and is soft and ductile. The cold working resulting from machining, however, transforms the surface to hard martensite, so that it is impractical to machine the steel at room temperature.

Under equilibrium conditions, the transformation temperature is 1250 F, above which austenite is in a stable phase and cannot transform to martensite. Hot machining appeared to be the ideal solution, and the expected ease of machining at temperatures above 1250 F was confirmed in hot-turning and hot-drilling tests. The satisfactory chips, work surface, and other cutting characteristics which resulted were similar to those observed in hot machining Vitallium.

Table 3—Hardness Change with Hot Machining, Arc Heating

Material	Hardness	
	Initial Rockwell C	Final Rockwell C
NE 8949	42	40
Vitallium	42	39
High-Speed Tool Steel	60	58
NR-76	26	23
NR-74	96[1]	85[1]

[1] *Rockwell B*

Other Alloys. Hot machining of other materials, including high temperature alloys, a fully hardened high-speed steel, and a low alloy, deep-hardening, nickel-chromium-molybdenum steel with high manganese content, also resulted in improved machinability. Results of these tests will be described in greater detail later in this article.

In these preliminary tests with gen-

eral-purpose carbide tools, the feasibility of hot machining was demonstrated using a flame-hardening torch to heat the work. It was recognized, however, that the power input to the work surface was inherently limited by the torch heating method. As a result, only slight temperature gradients could be achieved in the work piece. Since it was necessary to achieve high surface temperatures, the limited temperature gradient made it impossible to supply heat principally to the surface of the work. Instead, much of the heat supplied diffused into the work material. Nevertheless, these findings defined the characteristics of, and accelerated the search for, a practical heating means.

Development of Heating Methods

The advantages of hot machining can be obtained by using rather simple heating methods. Manganese steel bucket teeth, for example, can be furnace heated and drilled while hot. In other processes, where it is possible to heat the work throughout, flame heating can be used. As mentioned earlier, this latter method proved to be quite useful in some of the experimental work.

For many machining operations, however, it was desirable to have available a method which heats only the surface to be machined. With such a method, heating and machining could be accomplished at the same rate and the convenience of hot machining techniques could be made to compare favorably with that of conventional machining practices. In addition, the temperature of the workpiece would not rise significantly during machining.

Induction heating, at first consideration, appeared to be the heating means which would meet these requirements most effectively. However, a theoretical analysis demonstrated that the power densities required were greater than those which induction heating could supply. For that reason, and because of the expense of the equipment involved, induction heating was discarded.

Finally, tests were performed using arc heating, in which the arc was struck between the work and a carbon electrode. Extremely high power densities were obtained, but several minor difficulties plagued the initial arc heating tests. Because cold metal was continually being brought under the carbon electrode, there was a tendency for the arc to be extinguished. To correct this condition, a high-frequency, high-voltage spark was superimposed on the arc current. Then, when the arc tended to be extinguished, the core of ionized air produced by the spark provided a path for continued current flow, allowing the arc to be maintained.

Another difficulty encountered was the instability of the arc position caused by the motion of the work under the carbon electrode. This wandering of the arc produced an unevenly heated surface and prevented uniformity in the machining results. A solution to this problem was found by stabilizing the position of the arc with a magnetic field.

Rather simple means were used to determine the uniformity of heating. A fully hardened bar of SAE 4140 steel was prepared and the surface ground off until the surface hardness at any point fell within the range from 59 to 61 Rockwell C. A portion of the bar surface was then heated and allowed to cool. Since heating draws the temper of a hardened-steel bar, it was obvious that greater tempering would occur in the regions where higher temperatures were produced. After 0.010 in. was removed from the surface of the bar to obtain a smooth surface for testing, hardness readings were taken.

Before the use of the high-frequency spark and magnetic stabilization, the uniformity of arc heating was poor. It was found that the hardness of the bar had been reduced from about 60 Rockwell C in the unheated portion of the bar to 45 to 56 Rockwell C in the heated parts. This wide range of hardness values shows that small portions of the surface had been greatly softened, indicating that rather high temperatures were reached, and that other areas were essentially unaffected.

When the heating was done with an arc stabilized by the high-frequency spark and a magnetic field, however, the hardness readings of the heated metal varied only from 48 to 51 Rockwell C. The greater uniformity of heating indicated by these readings was also apparent from visual observations of the surface.

In addition, the arc heating process was found to be relatively efficient, with approximately one-half of the electric power supplied appearing as heat in the bar. Half of the heat in the bar, in turn, was confined to the chip, while the balance diffused into the workpiece.

The newly-developed arc-heating equipment (Fig 1) was soon being used in hot turning tests of many different materials, some of which are listed in Table I.

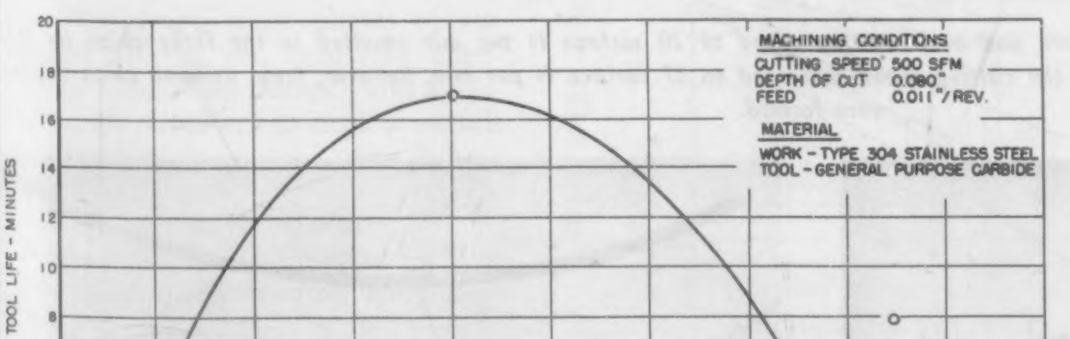


Fig 2—This typical workpiece temperature-tool life curve indicates the importance of machining at a proper temperature. Note the rapid decrease in tool life at temperatures above and below 400 F.

Effects of Hot Machining

One of the first factors considered in these tests was the possible effect of hot machining on the structure and properties of the work material. The control of structure and hardness consists largely of selecting a power density which will not overheat the workpiece in the thin layer just beneath the layer being machined. This fact was verified by photomicrographs made before and after hot turning, which showed little change in microstructure whenever heating was done at the appropriate power density. Surface hardness tests (Table 3) also indicated that tempering is minimized during hot turning.

The general effect of hot turning is shown in the tool life-cutting speed

Fig 4—The photograph on the left shows the surface of a Vitallium bar machined at room temperature. When the same bar was turned at an elevated temperature, a smooth, evenly-machined surface resulted (right).

curves of Fig 6, with the two highest curves representing the data for machining stainless steel. Note that, with a constant heating power density of 5.0 kw per sq in., a maximum improvement occurs at a cutting speed close to 600 surface ft per min. At this speed, the ratio of tool life in hot turning to that in conventional machining is nearly 8 to 1. This ratio approximates 7 to 1 at 800 surface ft per min and 2 to 1 at 400 surface ft per min. No benefit results from hot turning at 330 surface ft per min, since the two curves intersect at this point.

In explanation of this tool life-cutting speed relationship, it has been found that, at constant power density, the average temperature rise in the work surface taken over the cut depth is approximately inversely proportional to the cutting speed. But it was shown in Fig 2 that, for particular cutting conditions, there exists an optimum temperature for hot turning. The present data suggest, therefore, that the power density used yields the optimum work temperature at a cutting speed of 600 surface ft per min, under these test conditions. For practical purposes, it is desirable to achieve the optimum cutting condition at a cutting speed corresponding to an acceptable tool life.

The need for selecting the proper power density for hot turning is indicated by the stainless steel data of Fig 6, which show a tool life of only 10 min at 600 surface ft per min. A somewhat lower power density would yield a greater optimum hot-turning tool life at a cutting speed less than 600 surface ft per min.

Further evidence of the need for proper power density is shown by the high-speed tool steel curves in Fig 6, which represent performance at heating power densities of 5 and 20 kw per sq in. Since the material (Clarite hardened to 60 Rockwell C) was unmachinable at room temperature with the cutting speeds used in these tests, no zero power-density tests could be made. Even the data for the 5 kw per sq in. heating power density shows that a moderate amount of heating barely permitted turning. At 20 kw per sq in., however, a pronounced improvement in machinability was achieved. In machining fully hardened Clarite at 100 surface ft per min, for example, the tool life at 20 kw per sq in. is approximately seven times that at 5 kw per sq in. These data indicate that the power density available from the heating source must be high in order to fully exploit the potential advantages of hot machining.

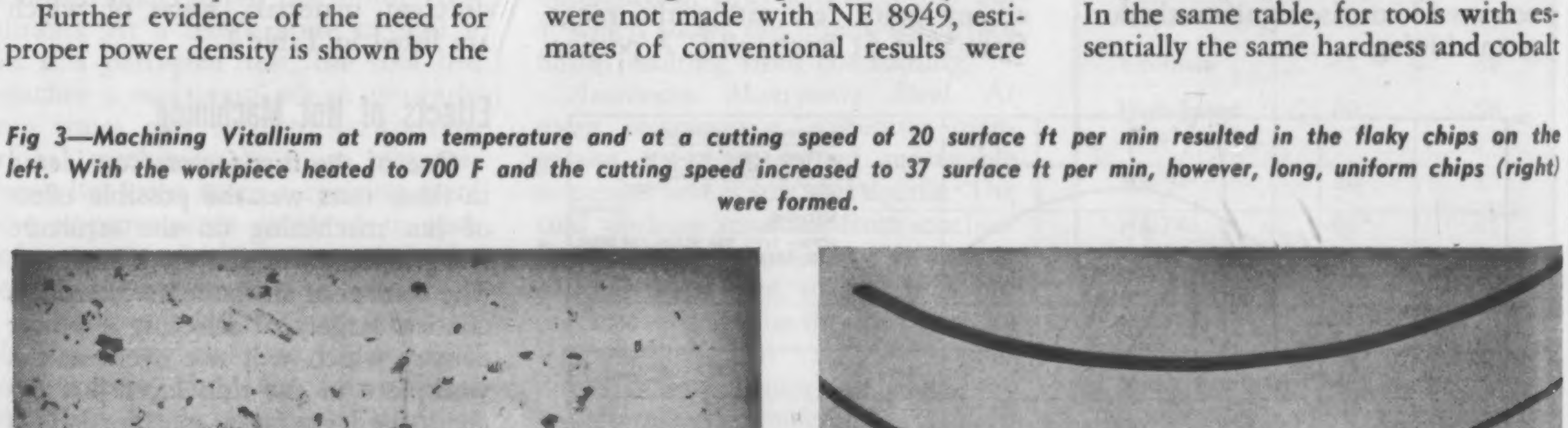
Data for NE 8949 in Fig 6, like those for stainless steel, show the diminishing advantage of hot turning at low cutting speeds. Again, it is believed that overheating at low speeds explains these results and that reduced power density would improve performance.

Although zero power density tests were not made with NE 8949, estimates of conventional results were available and could be used for comparison. The estimated life of a general purpose carbide tool for machining this material (42 Rockwell C) at 200 surface ft per min was 13 min. Under similar conditions, hot turning at 5 kw per sq in. resulted in a tool life of 20 min. Although a finishing grade carbide tool was used in this test, experience with NE 8949 suggests that a much shorter tool life would have resulted at room temperatures.

Other results indicated in Fig 6 are the equivalent hot-machining performance of the two turbine-blade alloys, NR-76 and Vitallium. A third such alloy, NR-74, hot-turned much more satisfactorily than the first two, although the room temperature machinability of the three alloys was comparable.

Tool life in hot machining is also dependent, of course, on the tool composition. Table 2 lists the compositions of different carbide tools which were studied for use in hot turning and a tool life index, based on the results of a standardized hot-turning test. It is apparent from the table that, for hot turning, the life of finishing tools is greater than that of general purpose and roughing tools. In the same table, for tools with essentially the same hardness and cobalt

Fig 3—Machining Vitallium at room temperature and at a cutting speed of 20 surface ft per min resulted in the flaky chips on the left. With the workpiece heated to 700 F and the cutting speed increased to 37 surface ft per min, however, long, uniform chips (right) were formed.



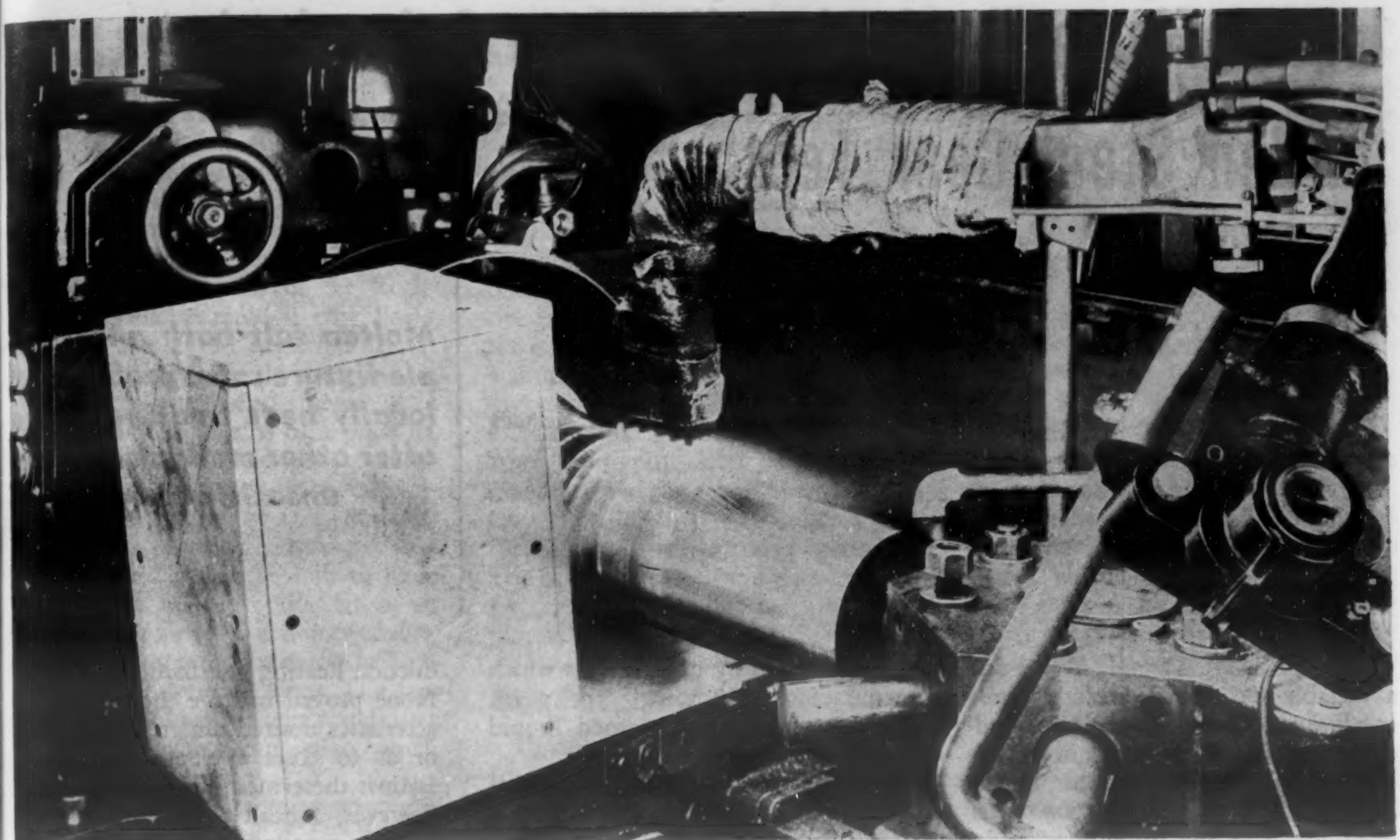


Fig 5—In early experiments with hot machining, this flame hardening torch was used to heat the workpiece.

composition, it can be seen that tool life increases with increasing titanium carbide content. This may indicate the improved oxidation resistance and high temperature strength of the higher TiC composition.

With the tool materials available at present, hard finishing tools exhibit twice the life of general purpose tools in hot machining. As harder tools are developed, even greater tool life can be achieved.

Hot machining has already proven to be an ideal solution to many machining problems. But despite the extensive tests carried on during the past few years, some phases of the process are, as yet, relatively unexplored. Continued research and application are necessary to exploit its full possibilities.

Acknowledgment

The potential advantages of hot turning with arc heating were suggested by the late Dr. H. W. Gillett, of the Battelle Memorial Institute. This and further assistance from Dr. Gillett during this work are gratefully acknowledged. The study was supervised by Drs. H. W. Russell and R. W. Dayton, and the research sponsored by the Warner & Swasey Co. Their encouragement during the work and permission to publish these results are greatly appreciated.

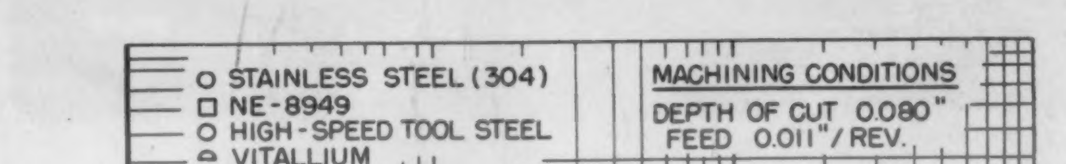


Fig 6—These curves demonstrate the effect of power density on the tool life-cutting speed relationship.

Liquid Flame Hardening Used to Selectively Harden Steel Gear Teeth

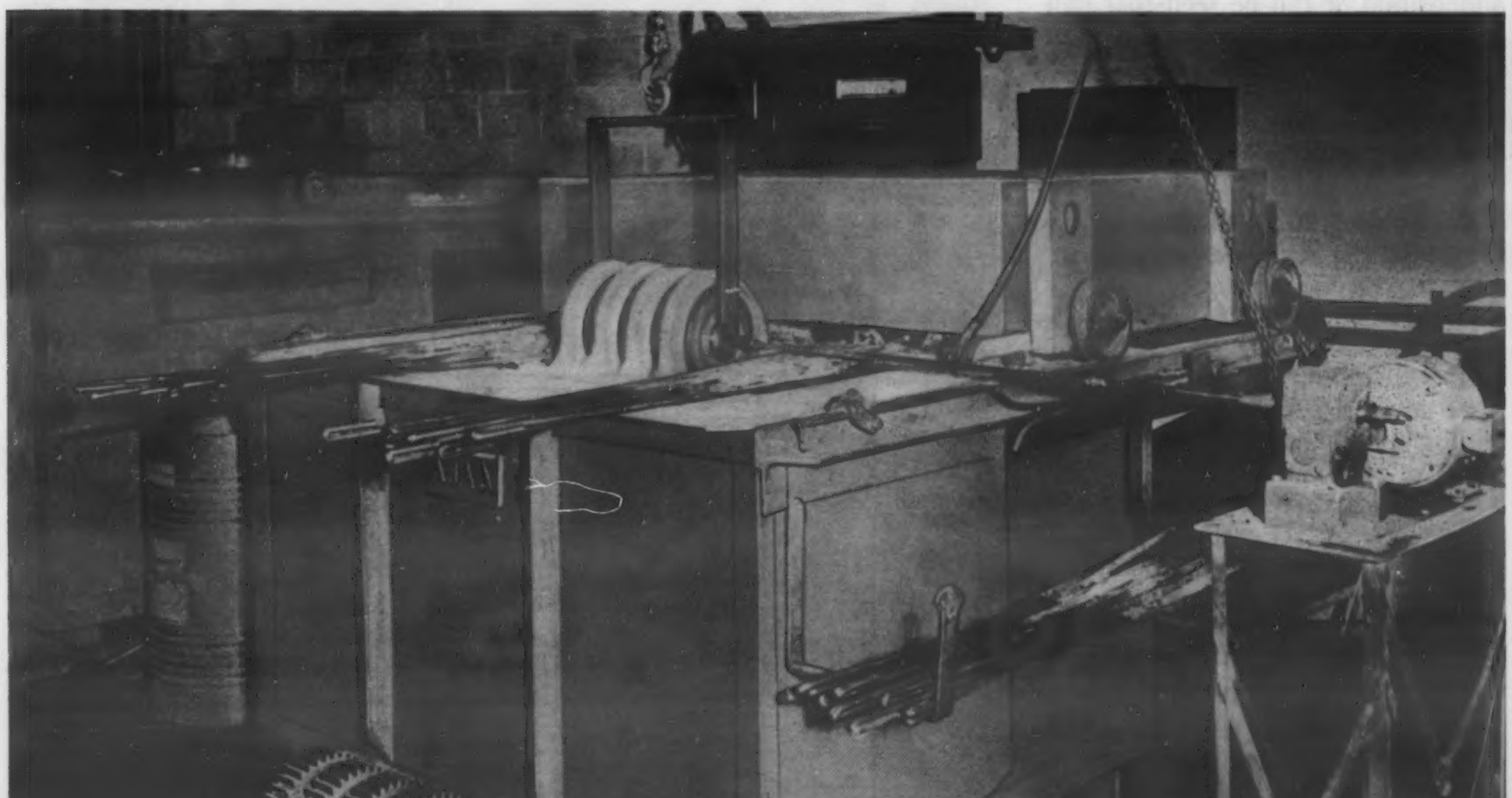
by T. C. DU MOND, Editor, Materials & Methods

Molten salt bath and simple fixture solve problem of locally heat treating gears after other methods proved unsatisfactory.

• A SALT BATH, a simple fixture and a variable speed drive seem destined to eliminate a good many gear hardening problems in the plant of the Philadelphia Div., Yale & Towne Mfg. Co. Mr. W. F. Sorenson, chief metallurgist of the division who developed the method, predicts its ultimate adoption by many plants which manufacture automotive type gears. The process has been named "liquid flame hardening."

In trying to find a suitable method for hardening the particular gear which led to the method's origin, the plant had tried overall heating, induction heating and flame hardening. None proved to have the ideal characteristics desired either as to results or as to costs. No prejudice holds against these methods for other uses, however, for all are used on other parts in the plant.

The problem was to harden the



Shown here is the Ajax salt bath furnace used to selectively harden steel gear teeth, four gears at a time. While one fixture holds the gears in the bath, a second is loaded so the furnace can be used continuously.

teeth of the gear shown in the accompanying illustrations. Gears made to these specifications were cut from drop forged SAE 4140 steel which had been annealed and normalized. They have an outside diameter of 11¼ in. and weigh 36¼ lb each. Each gear has 44 teeth and its hub has 18 splines. Service requirements dictate a tooth hardness of 52 Rockwell C, while the tough core has a hardness of only 36 Rockwell C.

Because the gear is designed to contact the outside diameter of a splined shaft by means of a press fit, it is essential that no distortion or opening up of the gear be encountered. As a matter of fact, the heat treatment is so designed that if anything, it will cause the hub to close slightly, less than a thousandth of an inch. If this amount is objectionable, a simple broaching operation will restore the spline dimensions. The fact that the hub closes slightly indicates that the gear is in compression, which is the ideal state.

Previous efforts to meet specifications on the gear led to burning or overheating the teeth ends, scaling, or required fixtures that were too complex and expensive.

In casting about for a solution to these problems, it was found that salt bath heating seemed to offer many advantages. Salt baths would prevent oxidation and could keep the steel at the correct temperature. The one drawback was that normally salt baths are used for heat treating an entire part, and not for heating around the edge of a circular part. Ultimately a simple fixture was developed which overcame the one obstacle to the use of salt baths. Accordingly, a standard Ajax Hultgren Salt Bath Burner, manufactured by the Ajax Electric Co., Philadelphia, was selected for this liquid flame hardening operation. The same activated cyanide bath used for regular carburizing work was employed.

Method Described

In effect, the method devised makes an ordinary salt bath semi-automatic in its operation. Parts to be heat treated are locked to a shaft which is free to revolve in a fixture. The fixture is held over the bath by means of a hoist and, when ready to treat the gears, it is lowered to a point which permits the molten salt to cover the teeth and rim completely. A variable speed drive, adjacent to the furnace, is connected to the fixture by means of a shaft and the unit is ready to operate.

With the variable speed unit driving the fixture, the parts are rotated in the bath at speeds ranging from 40 to 45 rpm. With the gears described in this article, four pieces are loaded in one fixture. A heating time of 4 min is sufficient to attain the desired temperature for quenching. This means a heat treating rate of one piece per min. The rate could be varied without difficulty by loading more gears in the fixture or providing larger fixtures. Likewise, gears of other sizes can be treated by the same method if proper fixtures are provided. Fixtures do not enter the bath, thus they are not subject to distortion.

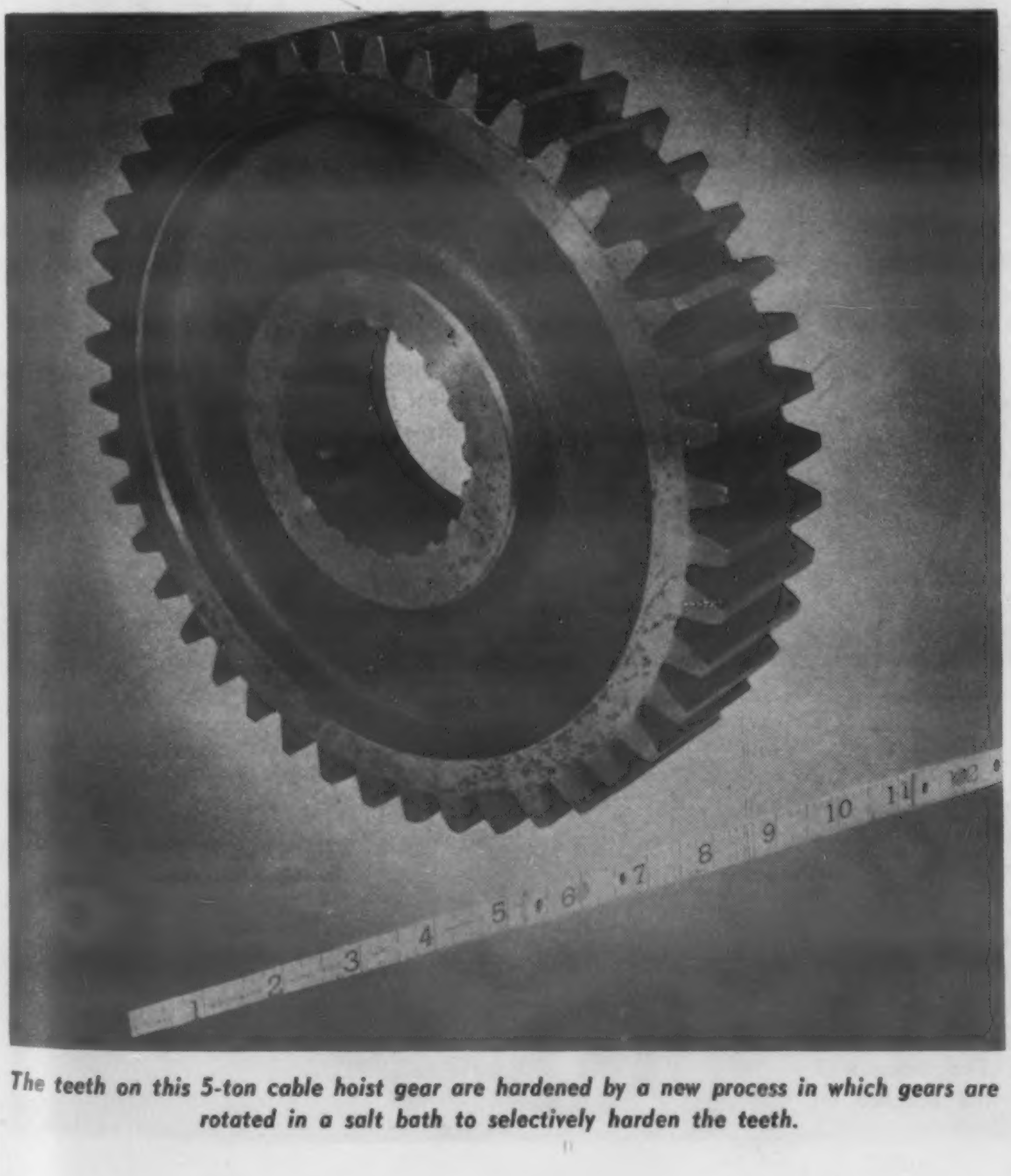
The speed of 45 rpm was selected because it is not so fast as to throw molten salt out of the furnace, but is fast enough to keep the part at temperature even though it is exposed to the air for a fraction of a second. The carry-out of salt from the bath, at this speed, is sufficient to keep the parts at temperature and at the same time protect them from the atmosphere.

Gears hardened by the method show uniform hardness throughout the entire area treated. Parts show no scale, and distortion is slight. The removal of a few tenths of a thousandth of an inch of metal in the splines is sufficient to make the gears meet dimensional tolerances, if any additional work is required.

For SAE 4140 steel used, bath temperatures are maintained at between 1525 and 1550 F. Carburizing or neutral salts can be used. Thus, gear treating can be done in baths which are used for other purposes. As a matter of fact, this practice is followed at Yale & Towne.

When heating has been completed, the parts are quenched in oil, which is maintained at a temperature of 150 F. The same hoist which holds the parts in the salt bath is used to swing the loaded fixture into the quench tank. Following the quench, the gears are tempered for about 45 min at 430 F.

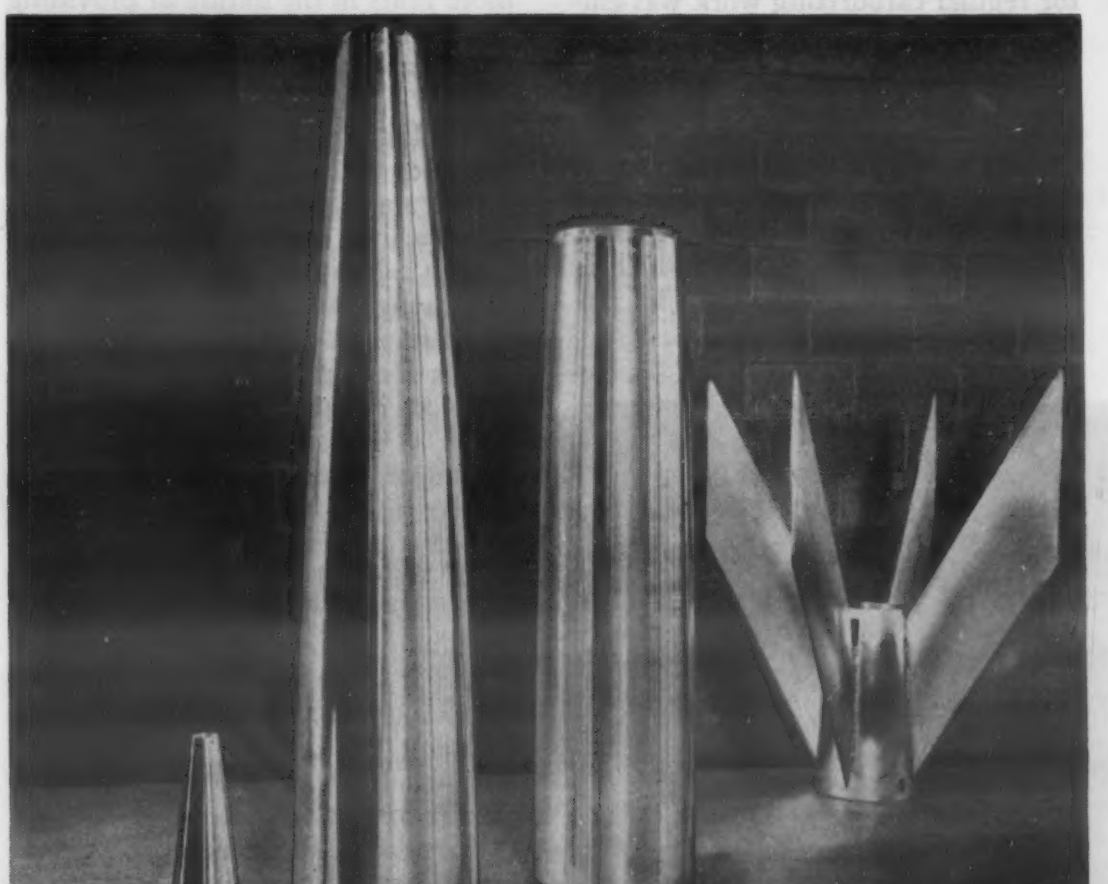
At present, this method of heat treating is being used on only one size of gear. However, as soon as other fixtures can be provided, more gears will be hardened by the same means.



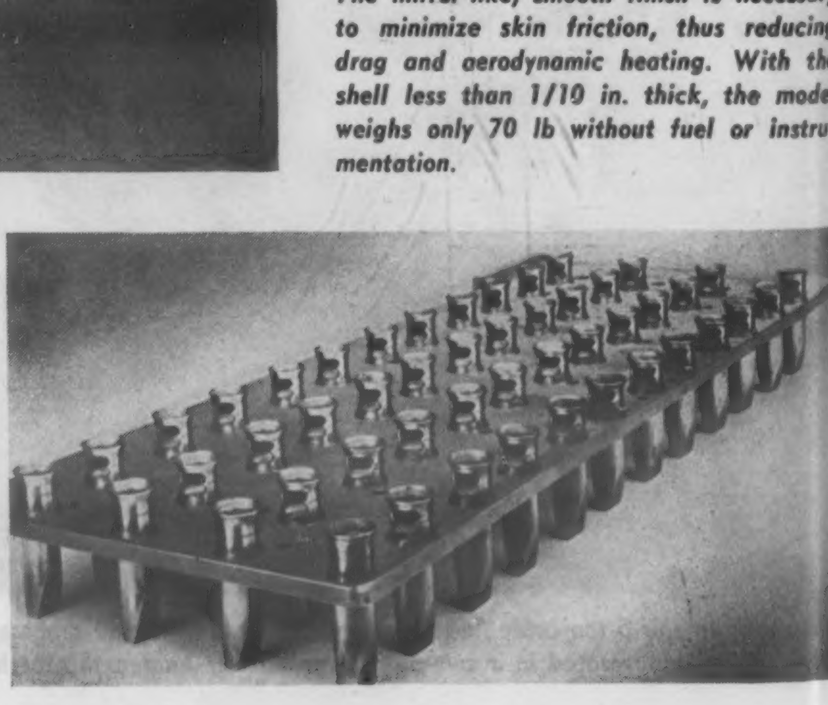
The teeth on this 5-ton cable hoist gear are hardened by a new process in which gears are rotated in a salt bath to selectively harden the teeth.

Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



SPUN MAGNESIUM ROCKET ***Joined together, these fuselage sections of spun magnesium form a pilotless supersonic model used by the National Advisory Committee for Aeronautics for research into the many aspects of high velocity flight. The mirror-like, smooth finish is necessary to minimize skin friction, thus reducing drag and aerodynamic heating. With the shell less than 1/10 in. thick, the model weighs only 70 lb without fuel or instrumentation.***



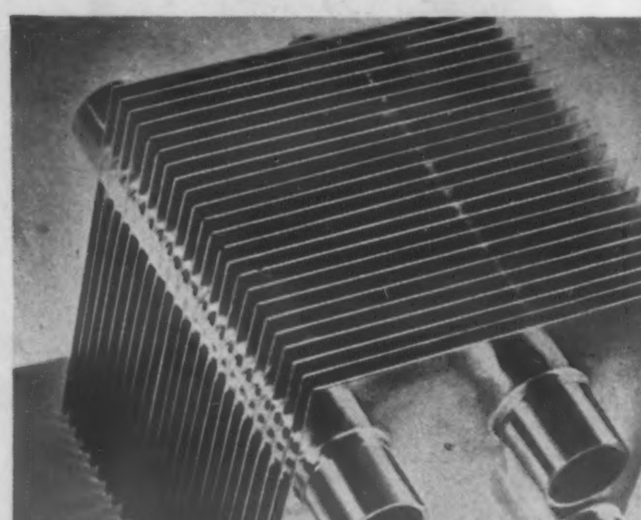
POPSICLE MOLDER ***A search for a sanitary method to increase production of popsicle-type products has resulted in this unusual stainless steel equipment produced by Anderson Brothers Mfg. Co., Rockford, Ill. Designed to hold many popsicle pallets, or sticks, at a time, each unit contains 48 Type 304 stainless tubes provided with a special annealed finish. The tubes, with a ½-in. O.D. and 0.021 in. thick, are flared and punched on one end and swaged on the other.***

LARGEST CONVEYOR BELT

A B. F. Goodrich engineer is dwarfed by this conveyor belt, the largest ever built and shipped in a single roll. Weighing 45,000 lb, the 48-in. belt will bring ore from ship to shore at a new railroad dock in Baltimore, Md. The 15-ft dia roll was the first major product of the new $5,000,000 B. F. Goodrich belt plant in Akron, Ohio.

HEATING AND COOLING COIL

This section from a heating and cooling coil is assembled by mechanically bonding four ⅝-in. dia stainless steel tubes to fins without using welding or soldering in the process. Flat plate-type fins of stainless steel are stamped and belled, forming a bonding collar at each opening and providing a broad, flat surface instead of a sharp edge at the point of contact with the tube. A tool steel bullet, propelled by compressed gas, is then forced through the tube, expanding it uniformly against the continuous surface formed by the collars of the fins. The resulting mechanical bond is reported to withstand repeated expansion and contraction caused by heating and cooling cycles. To meet the exacting requirements involved in this joining process, tubes with considerably closer tolerances than are ordinarily specified were supplied by The Carpenter Steel Co., Union, N. J.



How to Select Nonferrous Alloys for Investment Castings

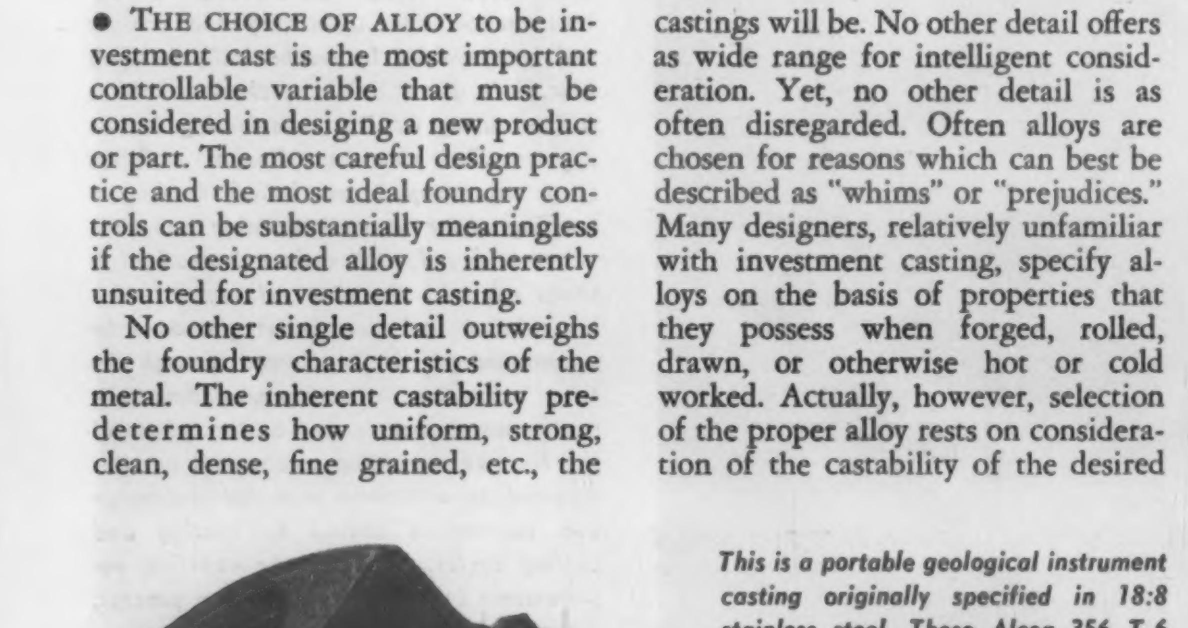
Foundry characteristics and engineering properties must be considered when choosing alloys for precision cast products.

by RAWSON L. WOOD,
President, Arwood Precision Casting Corp., and

DAVIDLEE V. LUDWIG,
Consultant

• THE CHOICE OF ALLOY to be investment cast is the most important controllable variable that must be considered in desiging a new product or part. The most careful design practice and the most ideal foundry controls can be substantially meaningless if the designated alloy is inherently unsuited for investment casting.

No other single detail outweighs the foundry characteristics of the metal. The inherent castability predetermines how uniform, strong, clean, dense, fine grained, etc., the castings will be. No other detail offers as wide range for intelligent consideration. Yet, no other detail is as often disregarded. Often alloys are chosen for reasons which can best be described as "whims" or "prejudices." Many designers, relatively unfamiliar with investment casting, specify alloys on the basis of properties that they possess when forged, rolled, drawn, or otherwise hot or cold worked. Actually, however, selection of the proper alloy rests on consideration of the castability of the desired metal.



This is a portable geological instrument casting originally specified in 18:8 stainless steel. These Alcoa 356 T-6 castings weighed 1 lb less than the steel, were entirely suitable for magnetic, strength and corrosion resistant properties, and cost considerably less to make.

Castability of alloys is a property complicated by many factors. Alloys which are ideal in theory for a certain casting application often prove to be unsatisfactory in practice because of the variability of their structures. In specifying any material for use in the cast state, therefore, its foundry characteristics must be given primary consideration. Whether or not the part will be subjected to subsequent forming, metal removal or heat treatments must be secondary.

Some of the factors which affect the castability of alloys are:

(1) Phase stability of the alloy; (2) chemical stability; (3) freedom from slag formation or drossing; (4) absence of dendritic cavitation tendencies; (5) absence of excessive hot shortness.

Uniformity of:

(6) cooling and solidification shrinkages; (7) reaction to environmental gases and solids; (8) fluidity at specific temperatures; (9) response to degassing and fluxing; (10) response to grain refinement and other treatments; (11) response to after-treatment in the solid phase; (12) or absence or reaction with casting equipment.

It should be noticed that stress is laid upon the uniformity of response to various factors. In most applications, a minimum amount of response is desirable. Where absolute stability is unobtainable, however (an extremely common occurrence), it is essential that such changes that take place follow a definite pattern—allowing the evolution of controls. An alloy that reacts unpredictably is un-

desirable for use in casting, particularly in the investment foundry.

Variables in Casting

Many alloys which are readily cast in sand or other relatively inaccurate molds are unsuitable for investment casting because of their variability in size and structure in cast form. Whereas deviations in size and structure are largely obscured in sand castings, they are immediately reflected in either the tolerances or the quality of investment castings. The high percentage of scrap obtained by using these alloys for investment casting results in excessively high costs. Use of basically stable alloys not only reduces the percentage of scrap, but improves the reproduction of details such as letters, serrations and threads.

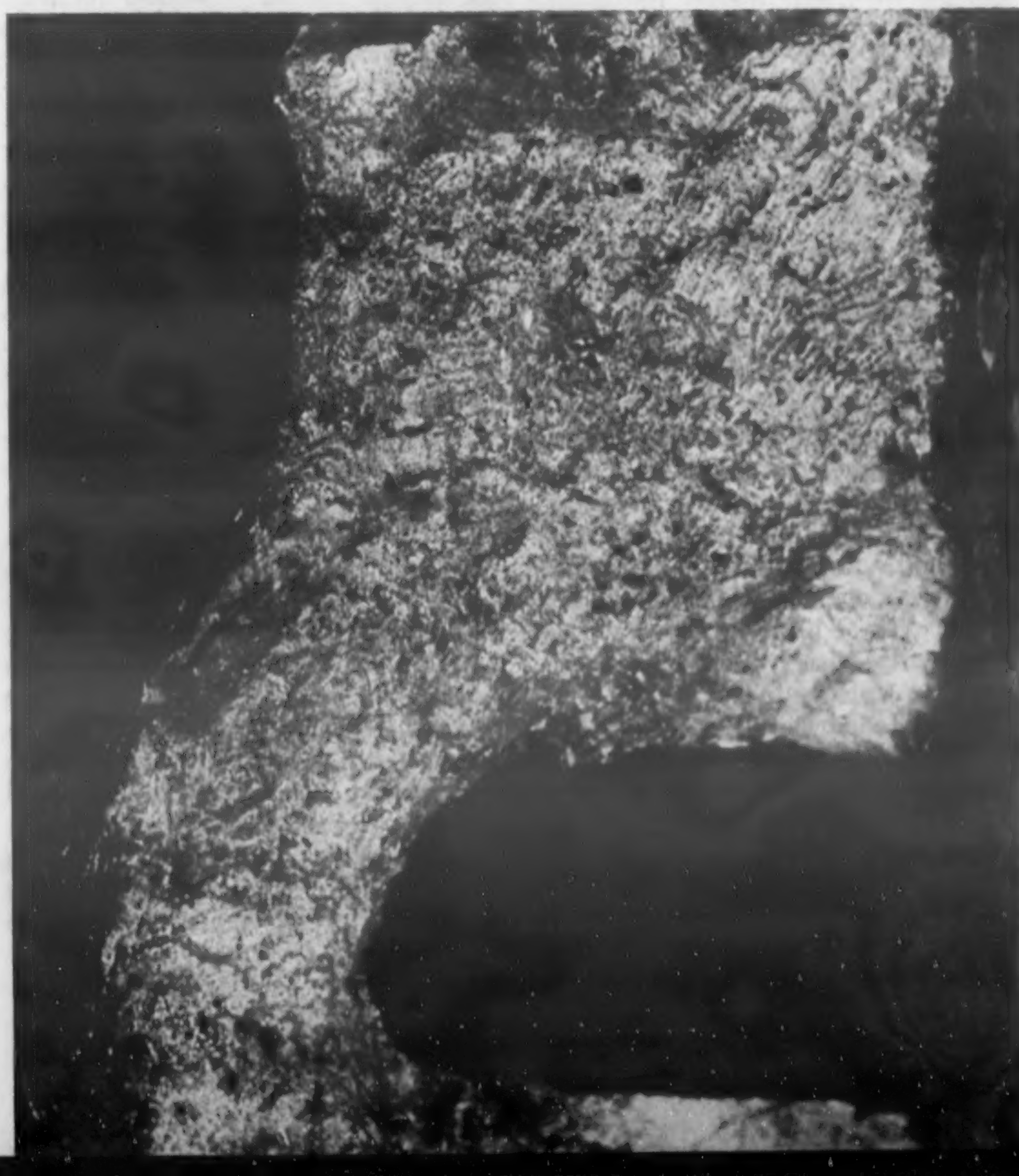
Because the investment casting process is able to form parts to tolerances in thousandths of an in. per in., the variations which arise as a result of deviations in nominal alloy composition, although confined to the chemical range specified, are often sufficient to cause the parts to be dimensionally inaccurate. In many of the low-temperature, nonferrous alloys, the difference in size between the parts cast from the alloys on the "high" and "low" sides is as little as from 0.001 to 0.002 in. When castings are specified within these limits, it is obviously of prime importance that the metal used be least susceptible to chemical change during the necessary melting and casting steps.

Since it is impractical to evaluate the effects of ambient atmospheric changes and modify the degassing or fluxing treatments for each melt, only alloys which are capable of responding predictably to a standardized process control should be used.

Assuming a norm of gas contamination can be set, any excessive contamination will result in the casting being oversized. Conversely, where less than the norm is encountered, the parts will be undersized. Where the same conditions are encountered in an alloy that is sand or permanent mold cast, the relatively higher rates of solidification combined with the far broader tolerances provided usually totally obscure the dimensional changes effected. In investment castings, the variation of gas content can result in size variations of certain alloys in excess of ± 0.001 in. per in., requiring many of the castings to be scrapped and raising costs to a prohibitive level.

The most important investment-

***Above:** This 85-5-5-5 brass casting was required to have complete pressure tightness after several fine passages for air were drilled through the heavy sections. The high ductility and strength of the cast red brass is indicated by the amount of deformation evident in fracture testing a scrap casting. **Below:** The relatively fine, dense grain structure of the fractured red brass alloy casting is indicated in this macrophotograph of a broken section.*



cast nonferrous alloys, in normal engineering applications, are based on aluminum, copper or magnesium. There is little demand and less justification for investment casting zinc, lead or tin alloys. The use of semiprecious and precious metals, such as silver, gold, platinum and iridium, is facilitated by application of the investment technique because of reduction of costly waste in the foundry and in finishing the parts.

Magnesium and Aluminum Alloys

Of the several castable alloys of magnesium, only one is suited to the investment process. This is the alloy commonly called Dowmetal C. The properties of this metal when investment cast are substantially the same as when it is sand cast and the response to heat treatment is the same. Since minor differences between "C" and other magnesium alloys are completely outweighed by the lack of castability of the others, there is no rational justification for using another alloy when investment cast magnesium is to be used. Thousands of precise castings of Dow "C" alloy have been made with satisfactory results.

Nearly all grades of aluminum can be investment cast. All of the silicon-aluminum alloys are particularly suited to the investment process, but the copper-aluminum and zinc-copper-silicon-aluminum alloys are somewhat less satisfactory. Magnesium-aluminum alloys present all of the difficulties encountered when they are cast by other techniques.

But the best aluminum alloy for investment casting is the silicon-magnesium-aluminum alloy commonly designated Alcoa 356, available as-cast and in three different stages of heat treatment. The range of physical properties covered by this alloy duplicates or exceeds all actual properties obtainable in any other aluminum-base alloy. Although the theoretical values of other alloys, such as Alcoa 195, are higher than those of 356, it has been demonstrated repeatedly in actual practice that the greater stability and superior foundry properties of 356 produce castings which possess higher average properties than any of the alternate high-strength, heat-treatable aluminum alloys. This is corroborated by published findings based on the properties of sand casttings of both 356 and 195 alloys.

None of the other aluminum-base alloys possess the combined properties of reliable foundry performance, highest fluidity, inherent stability, and flexible and reliable response to heat treatment, in addition to the optimum performance factors of high strength, impact resistance and good machinability. The use of any other aluminum alloy than 356 can only be justified in those instances where an unfavorable electrochemical differential cannot be avoided.

Because of the retarded rate of cooling which occurs in the hot ceramic molds, the grain size of investment castings is generally larger than that which would result from forming the same alloy by chill castings. Of all the normally cast aluminum alloys, type 356 is least susceptible to grain coarsening. But it has never been established that large grain size has any practical effect on the strength or endurance of investment castings. On the contrary, in many instances the performance of investment castings has exceeded that formerly obtained by machined sand castings or machined forgings.

Copper Alloys

There are more commercially significant alloys based on copper than on all of the other families of nonferrous alloys combined. No single copper alloy is as outstanding as the 356 type is among aluminum alloys. There are, however, several outstanding copper alloys which should be used whenever possible.

The most adaptable alloy for general design use, where high strength, good wear resistance, inherent density, good appearance and machinability are required, is silicon brass. This material is one of the most castable of the copper alloys. Reluctance on the part of many foundries to use this metal in place of free-machining, lower strength brasses is based largely on misconceptions about the difficulties of machining it. Slight changes in tooling and techniques can completely overcome any difficulties that may exist, making the machinability of silicon brass a negligible factor in consideration of alloy choice for investment casting.

The silicon in silicon brass is believed to act as an effective deoxidizer which imparts high fluidity to the metal and eliminates the factor of gas absorption. The metal can therefore be poured at comparatively low temperatures into molds which are substantially cooler than those required for less castable brasses and bronzes. This results in a pronounced tendency for the silicon brass castings to be more uniformly dense, usually free from the effects of characteristically high shrinkage and, in combination with the fluidity factor, to possess high accuracy in detail rendition. In addition, the lower temperatures involved sometimes permit the parts to be poured within 100 F of the melting point, with the result that solidification and contraction stresses are minimized. Such castings not only possess higher initial accuracy, but tend to remain dimensionally stable.

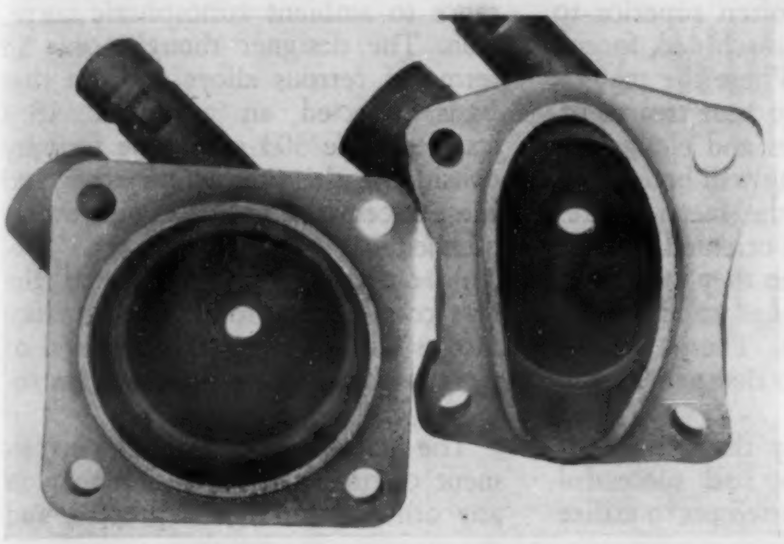
Where the part design involves considerable or precise finish machining, red brass, otherwise known as 85-5-5-5, is most satisfactory. This alloy combines reasonable foundry properties with good bearing characteristics, good machinability, pressure tightness and moderately high strength. The properties of red brass investment castings equal or exceed the properties obtainable by sand casting the metal. It is the only lead-containing brass or bronze which presents few difficulties to the investment foundry.

High zinc brasses are not ideal casting alloys, and the common difficulties encountered with them in bulk foundry processing become accentuated in investment casting. The most common reason for dependence upon these high zinc or yellow brasses is their good machinability. This consideration is pointless, of course, when contemplating the correct alloy for investment purposes.

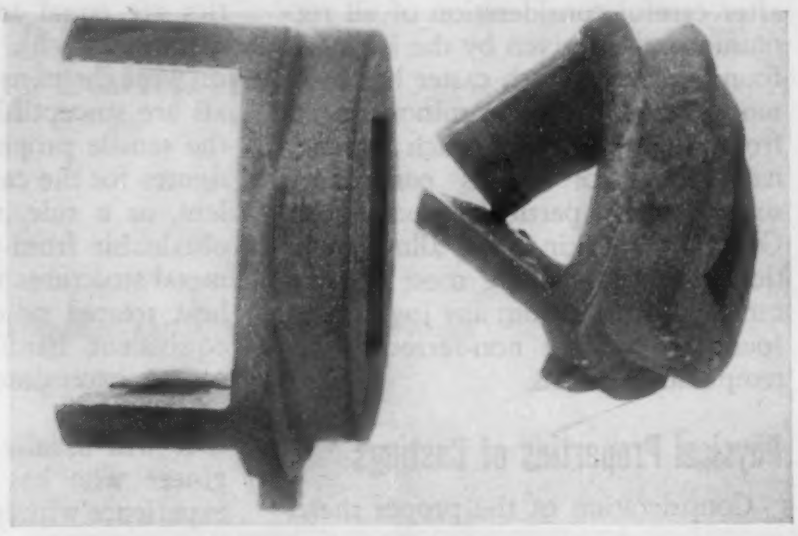
Non-leaded yellow brasses produce castings which are subject to pits and dross inclusions and, although these defective parts are removed at the foundry level, the percentage of scrap and the resultant part price is high. Addition of lead to the yellow brasses compounds the difficulties of handling the material. In spite of these difficiencies, leaded yellow naval brass is being founded in considerable quantities. Yet, in nearly all applications, the cost of the part would be less and its functional worth greater if either silicon brass or red brass were substituted.

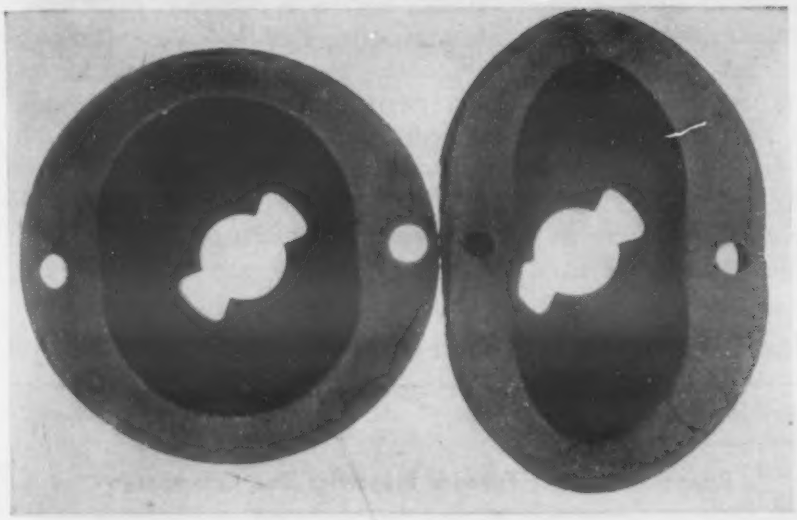
Manganese bronze is difficult to control because of its susceptibility to gassing and the high rate of evolution of zinc and the formation of dross. Despite the presence of zinc and manganese, both strong deoxidizers, manganese is particularly sensitive to changes in atmospheric conditions. Furthermore, when free from gas, it is a notoriously high shrink metal. However, the nominal properties of sound manganese bronze, higher than any other copper alloy except heat-treatable grades of aluminum bronze

The high strength of this manganese bronze aircraft casting is indicated by the distortion of the test casting, which showed no signs of fracture after being pressed with more than 4500 psi pressure.

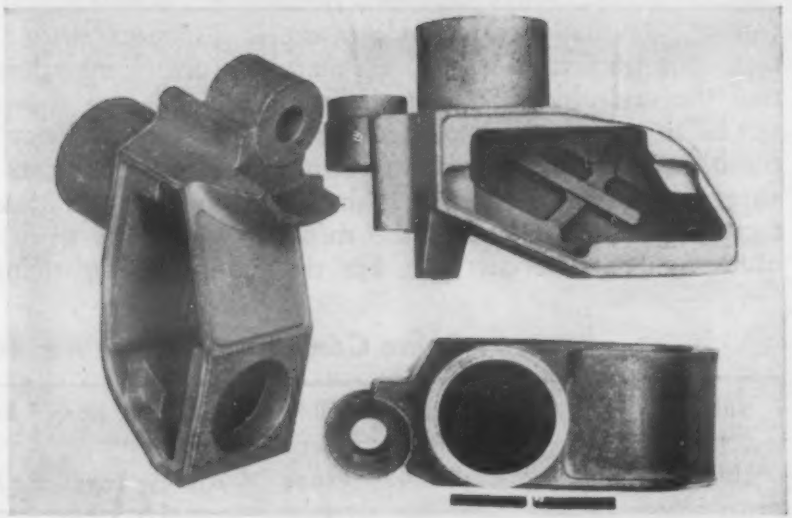


Even leaded yellow brass can be made to withstand considerable stress without fracture. Distortion of this postage meter stamp blank casting occurred without any sign of cracking.





The strength and ductility of silicon brass investment castings are illustrated by the amount of distortion sustained by this pressure-tight pump housing casting which was pressed until fracture commenced.



This casting is a magnesium Dow "C" vest pocket binocular housing. Only through use of the investment process was production of this intricate part commercially feasible. The walls are held without draft to 0.030± 0.002 in.

and beryllium copper, result in its frequent application in spite of the difficulties of casting it. Because of the variability in the structure of manganese, silicon brass usually can be used as a safe alternate material for it. The only remaining reason for using any of the yellow brasses, the desire for the particular color of those alloys, is essentially unimportant in the selection of an engineering material.

The fluidity of the red and yellow brasses and bronzes is inferior to either beryllium copper or silicon brass, the latter of which is most generally credited with maximum fluidity. But the powerful deoxidizing effect of the beryllium in alloys containing it makes them as fluid as silicon brass when proper foundry melting equipment and controls suitable for handling the rather sensitive beryllium-containing metals are used. Unless considerable care is exercised in melting and pouring the beryllium alloys, quantities of microscopic particles of beryllia are formed which tend to embrittle the alloy as well as render it subject to variable results in heat treatment.

The molten beryllium copper alloys remain highly fluid or "sharp" at temperatures within 100 F of their melting points. This assists in production of small detailed castings free from solidification stresses.

Beryllium-copper castings are comparatively costly, especially in large parts. Aside from metal cost, an important control problem which restricts more universal application of these metals is the difficulty of determining the exact proportion of "available" beryllium contained in each heat of metal. Because of the extreme affinity of the beryllium for oxygen, it rapidly is transformed to beryllia. Normal chemical techniques cannot readily discriminate between the residual active alloy metal and the passive oxide. As a result, it is necessary to tailor the heat treatment cycles to conform to the responses of each heat. This requires having the heat treatment performed by the foundry or a shop particularly experienced in determining, by empirical means, the response characteristics of differing melts of beryllium alloys. This is not a major deterrent to the use of the metal in applications designed to make use of its special properties.

Most of the tin bronzes can be cast reasonably well. The addition of phosphorus is usually desirable to obtain good fluidity and freedom from tin-zinc drosses. High-conductivity phosphor copper and electrolytic copper can be cast with less difficulty than that normally encountered in sand casting methods, but with great difficulty nevertheless. For most electrical purposes, beryllium copper or the tin bronzes, such as 88-10-2, prove ade-

quate in the investment cast form.

Final alloy determination for investment cast parts should be made after careful consideration of all recommendations given by the intended foundry source. Each caster has techniques which differ in minor aspects from those of others. Each foundry has groups of metals particularly suited to its particular techniques. Generally speaking, the alloys mentioned above as being most castable can be procured from any investment foundry handling non-ferrous, low-temperature metals.

Physical Properties of Castings

Consideration of the proper metal must include all usual engineering factors. Where alloys have not been formerly available to the trade in the cast condition, it is best to estimate that the cast physical properties will not be as good as the maximum stress results for directionally oriented structures in forged, rolled or drawn forms, and not as bad as the minimum figures. The cast part has the distinct advantage of lacking orientation of structure, with the result that its vibration and fatigue characteristics are equal and often superior to those obtainable in machined, forged or wrought parts. Where the materials are susceptible to heat treatment, the tensile properties and elongation figures for the casting will be equivalent, as a rule, to the mean figures obtainable from the oriented worked metal structures when they have been heat treated *or worked* to the same equivalent hardness. There are, of course, exceptions to this generalized statement.

It will usually pay the design engineer who has not had successful experience with his attempts to utilize the investment process to consider his metallurgical factors in close conjunction with competent foundry control metallurgists. Errors of alloy choice are inevitable. Some are due to the tendency for design and materials engineers to get into a rut in their metals ideas. An extreme example of such an error, illustrated in an accompanying photograph, is in a part for a portable geological survey instrument. The special properties desired were non-magnetism and resistance to ambient atmospheric corrosion. The designer thought only in terms of ferrous alloys and, on that basis, selected an austenitic 18:8 stainless type 303 steel. The foundry considered the production costs and the performance required and recommended use of aluminum type 356. This change not only reduced the first cost but improved performance factors and saved over one pound of weight in the hand-carried instrument.

The field of alloy choice in investment casting is more varied than in any other metallurgical process, and the range of preferred investment casting alloys is rapidly increasing. Metals being handled as routine today were considered impractical less than two years ago. As new metallurgical equipment and standards are evolved, and design engineers become familiar with the alloys most suitable for investment casting, this trend will continue to accelerate.

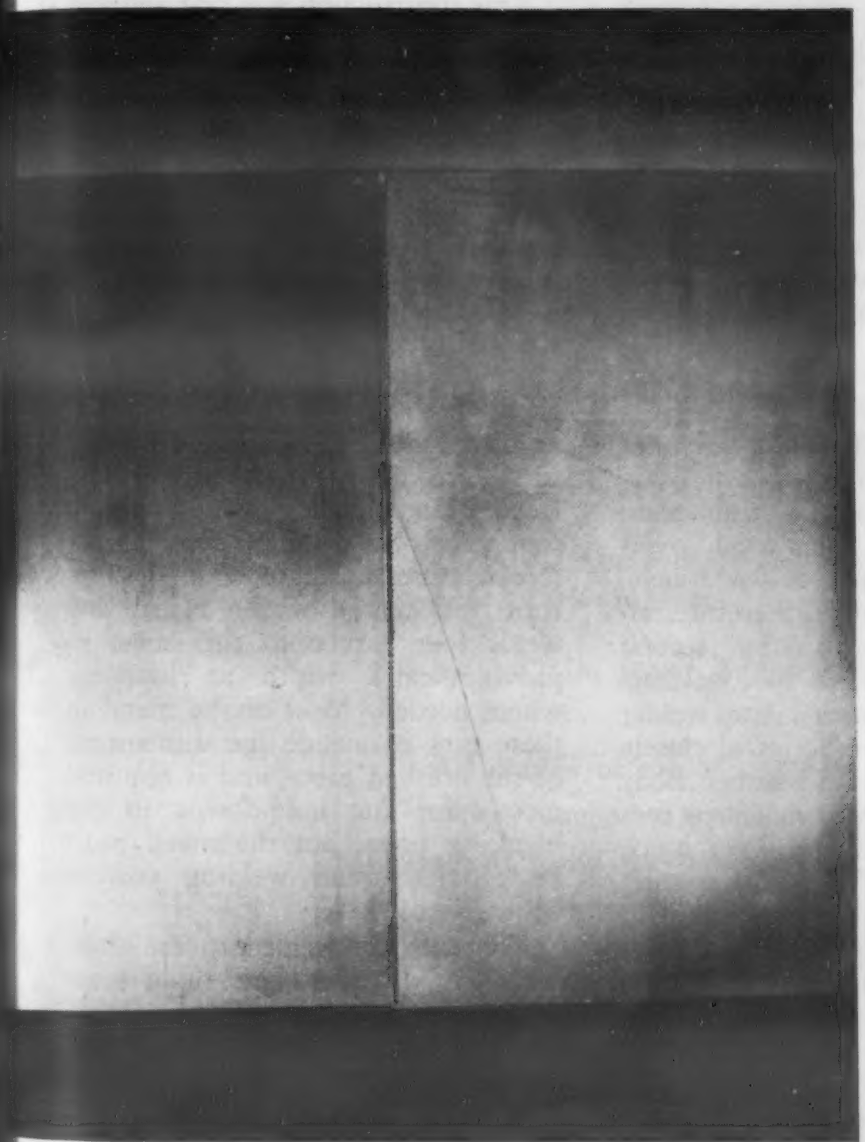
Some Commonly Available Nonferrous Investment Cast Alloys

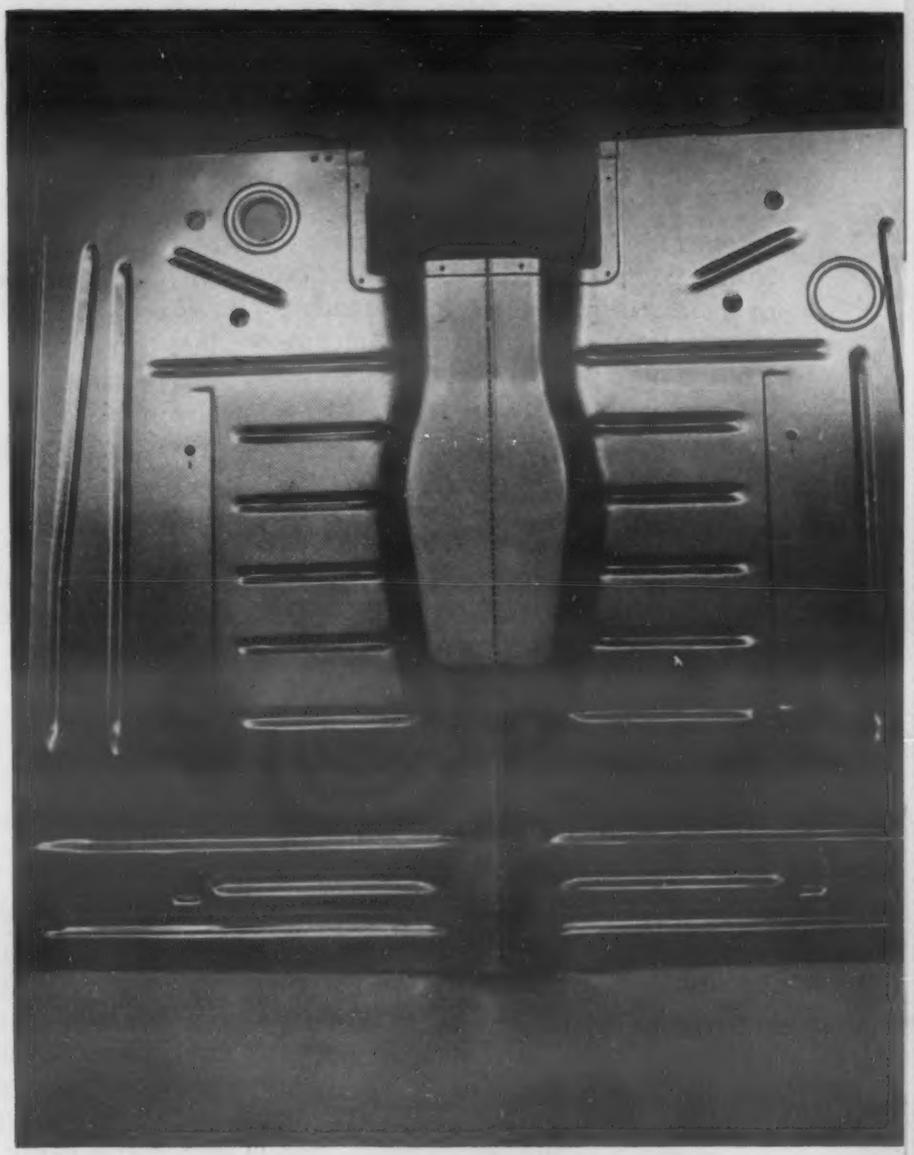
Usual Alloy Identification	Tensile Str (10 Psi)		% Elongation		Rockwell Hardness		Foundry Properties and Comments
	Ave.	Range	Ave.	Range	Ave.	Range	
Aluminum Base Alloy #43	17	16-22	4	3-7	30E	—	Easily cast, but no advantage over type 356 as cast in most uses.
Alloy #356 (As Cast) #356 T-6	21 38	17-24 33-42	4 4	3-7 3-6	35E 75F	30-38 70-80	Easily cast. Best alloy for investment use and best for nearly all engineering purposes.
Alloy #B195 (A.C.) #B195 T-6	22 38	16-25 30-42	4 3	3-6 2-6	36E 75F	30-40 68-84	Poor foundry alloy, pronounced tendency toward segregation, difficult to heat treat. Not recommended.
Magnesium Dowmetal C (A.C.) Heat Treat & Aged	21 36	18-24 30-40	3 3	2-6 2-6	38E 78F	30-42 70-85	Best magnesium alloy for investment casting, recommended where maximum strength and minimum weight needed.
Copper Base Electrolytic	—	—	—	—	—	—	Used only for electrical purposes.
Yellow Brass	33	30-36	25	20-35	70E	65-80	Not highly recommended for investment.
Naval Brass (Leaded)	47	44-50	20	18-29	85F	75-100	Not highly recommended for investment.
Red Brass (85-5-5-5)	36	30-40	23	20-30	70F	65-75	Recommended for pressure-tight and bearing uses.
Silicon Brass	48	45-60	19	17-23	80F	75-100	Recommended for most stressed uses and all general casting purposes.
Tin Bronze	47	40-51	42	22-57	80F	70-90	Recommended for general casting purposes. Not as good as silicon brass for foundry properties.
Manganese Bronze	77	65-83	23	20-33	95F	90-110	Difficult alloy to cast, requiring special gating and foundry practices; used for high strength parts. Silicon brass is a recommended alternate.
Aluminum Bronze (A.C.) Heat Treated	50 82	45-60 75-100	15 13	12-20 10-18	80F 90B	75-90 85-110	Poor foundry properties, used for maximum abrasive wear resistance and high strength.
Beryllium Copper (A.C.) Treated and Aged	77 176	75-85 176-210	20 3	15-25 **	100F **	90-110 38-42C	Excellent copper-base alloy for investment casting. Available in numerous heat treated conditions within the ranges indicated.

***Actual elongation, tensile and hardness figures are dependent upon precise heat treatment used; results controllable between minimum as cast figures and maximum hardness shown. (Figures shown are not specification figures but are typical test bar results; they may be higher or lower than published trade specification standards and are for information only.)*

Welded Narrow Steel Sheets Used for Wide Stampings

by KENNETH ROSE, Western Editor, Materials & Methods





Blank (at left) for front floor pan stamping (at right) is made by welding together two narrow sheets.

Considerable savings in metal costs followed adoption of this method of producing large automotive stampings.

• THE AUTOMOTIVE INDUSTRY is one of the largest users of sheet steel in American industry. Highly competitive and keenly price-conscious, it developed the all-steel automobile body as a successor to the wooden body because of the economies and improvement in product the change made possible. Many of the techniques and machines for forming and welding of steel were developed by the automotive industry or its suppliers in answer to the steady demand for ever more effective use of the material.

One of the techniques developed as a result of this price-consciousness has been the joining of steel to form wide sheets for the body stampings of today's streamlined cars. The in-

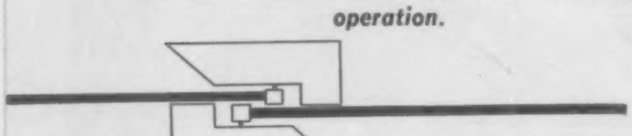
centive has been two-fold:

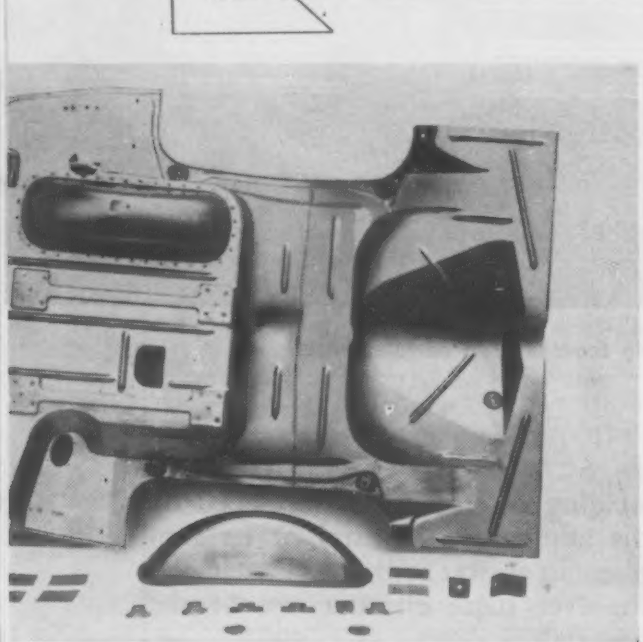
1. Wide sheet steel carries a high price extra. The extra charge made by the producers of sheet steel for widths is lowest for the 36- to 48-in. widths in 20-gage sheet, and the increase becomes twice this for 62- to 72-in. widths. This means that the steel for a blank 72 in. wide will cost nearly twice as much per pound as steel in the 36-in. range.

2. As the width of the sheet increases, the number of possible suppliers decreases. Only a few mills have facilities for rolling the greatest widths of sheet, and in times of scarcity the number of possible alternate suppliers is one of the greatest importance to large users. The purchaser of 72-in. sheet has eliminated probably three-fourths of the industry's capacity from his list of possible suppliers. As present conditions of tightening supply and unavailability become more acute, the methods developed by the automotive industry to overcome these difficulties will be of increased interest to other branches of manufacture. They offer the possibility of a solution that will also provide a saving in costs.

Members of the automotive industry have solved the problem in many cases by welding. The best solution may involve (a) welding together two narrow sheets, or (b) welding ears onto a wide sheet to increase the width at certain locations. The solution depends upon consideration of several factors other than price, including the location of the stamping in the car body, whether visible or concealed, and the severity of the forming at the weld. After the feasibility of joining the steel has been decided upon, the welding method to be used must be selected with forming and other processing requirements in mind.

This Z-bar makes the overlap in the two narrow sheets just before the welding operation.





This rear section of the floor pan is made at Ford from two narrow sheets which are joined by seam welding. The method results in cost savings by avoiding the extra price charged for wide sheet steel.

Welding Methods

Four welding methods are being used to join steel for wide stampings. Two of these, seam welding and multiple spot welding, produce a lapped weld, and are not suitable for exposed surfaces. Local clearance is required in the dies to permit forming of the sheet with the double thickness at the weld. Two others produce welds that, with a little grinding, are invisible after the application of primer coat and baked enamel. These methods are flash welding and mash welding.

The seam welding method is usually applied to the production of a roll seam, in which a succession of spot welds are made without overlapping, rather than a true seam weld, in which the spots would overlap to form a continuous fused weld. The weld produced is, therefore, almost identical with the second method listed, multiple spot welding.

Ford Motor Co. uses a seam welder to join sheets with a series of closely spaced spot welds, and Fisher Body Div. of General Motors Corp. uses multiple spot welding to get much the same result. The actual spacing of the spots, by either method, will depend upon the forming stresses in the piece during the press operation to follow. At the Ford plant wide sheets for both the front and the rear floor pans are made by welding together two narrower sheets, and as the metal is not severely worked, the seam is made with three spots to the inch. The metal used is SAE 1010 deep drawing steel of 20 gage. Where the forming will stress the metal at the weld more severely, spots must be spaced closer to prevent tearing.

For the Ford operation, the front floor pan requires a blank 60 by 69 in., and the rear floor pan a 70- by 86-in. blank. The former blank is made by welding together two pieces each $34^{13}/_{16}$ by 60 in., with about ⅝ in. for overlap, and the latter by joining pieces 36⅛ by 70 in. and 50½ by 70 in. with the same overlap. The two sheets to be joined are loaded manually onto a feed table, and the paired pieces are then pushed against a Z-bar by spring-loaded rollers, which spaces the overlap. The pair is then fed under the rollers of the roll seam welder, which makes the weld at the rate of about 38 ft per min.

While the double thickness of metal at the weld requires local clearance in the forming dies, the pieces run well in the press. Structurally, the welded pieces are amply strong and, as they are not on upper exposed parts of the car body, the visible overlap at the weld line is not objectionable.

This construction was first adopted during a period of steel shortage, when wide sheet was unobtainable. The Ford Co.'s own steel mill was not equipped to roll the wide sheet, and the welding of narrow sheets was tried to solve the difficulty. The result was so satisfactory that the practice was continued.

Where the welded portions will appear in the upper exposed portions of the car body, the problem requires either flash butt welding or mash welding, which finish with only a single thickness of metal at the weld. Budd Manufacturing Co., supplying roof panels to an automobile manufacturer, uses a single wide sheet to form the center of the blank, and welds four ears onto this sheet to provide extra width at locations where needed. Most of the metal in these ears is outside the dimensions of the finished piece, and is required mostly for the hold-downs in the blanking press, but the metal must be provided, and welding reduces the steel cost.

The ears are welded to the sheet by mash welding, done on a seam welder. As with all mash welds, wheel maintenance is high. The welds are made at about 120 in. per min. After the weld is completed, it is ground down flush to remove the slight thickening of the metal at the weld line.

Metal cost savings effected by the use of welding to produce wide blanks from narrow sheet will vary, but the amount is considerable, as can be understood from the figures given. On high production items like automobile bodies savings can total many thousands of dollars per year. With small pieces in other industries the extra charge for wide widths may not offer the same possibilities, but welding costs are low, and the method deserves consideration.

Materials & Methods Manual

66

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

Review of Materials Engineering Developments in 1950

by T. C. Du Mond, Editor, Materials & Methods

All phases of materials engineering have benefited by developments which reached a practical point during the last year. Progress seems to be channeled in the direction of providing materials that will withstand difficult service conditions as well as in making more simple, inexpensive and certain the necessary processing techniques.

Contents

Materials Engineering Developments of 1950

In one important respect 1950 proved to be almost the exact opposite of its predecessor year. In 1949, you may recall, the early months saw materials supplies low and their prices high. As the year passed, supplies became almost bountiful and prices became more reasonable. This Utopian condition continued through the first half of 1950 until the outbreak of war, and the threat of a larger and longer war caused a mad scramble for all engineering materials. Naturally, prices shot up until we all now are paying more for everything than at any time since price controls were lifted.

Now, to make the materials engineer's life more complicated, we pyramid use restrictions, voluntary allocations and D. O. priorities atop dwindling supplies and soaring prices. Now it is more important than ever that engineers, designers and others learn about new developments in materials in order that they might make the best of a difficult situation. These men can help themselves, their companies and their country by knowing where and when substitutes can be used for scarce materials, how to work the less highly alloyed steels, and if some of the newer forming methods will help them save materials as well as cut down on machining and finishing requirements.

The usual developments spurred on by huge defense appropriations did not come in time to make their debuts during 1950. Rather, those developments which did come resulted primarily from research conducted by private industry, or for industry by the many research institutes now functioning in attempting to solve peace-time problems. One year hence we shall probably be able to report on war-spurred progress.

As has been the case for each of the years since the mid-forties, there have been new attempts to meet the insistent demand for better and stronger high temperature materials. During 1950 we heard of iron-base alloys, ceramics and silicones which might prove to be the answer. Without anticipating the impending shortage of columbium, stainless steel producers developed steels of this class which are extremely low in carbon and, therefore, can substitute for stabilized stainlesses in welding applications. Other developments in irons and steels include age-hardenable stainless steels, special alloys for specific uses such as metal television tubes, better heat treating methods and new methods of machining.

The newer metals titanium and zirconium have been joined by other new ductile metals, including tungsten, vanadium, chromium and molybdenum. As always, the more generally accepted and used alloys have been improved.

Most important of the developments in nonmetallic materials has been the compounding of new silicone rubbers. The improvement in silicones most likely to find widespread acceptance is a material having a service temperature range from −100 to 500 F, with some applications reaching to between 600 and 700 F.

As in all recent years, 1950 saw many changes in the way parts are formed. Of primary interest is hot extruding of steel, which was introduced from France. Hot extruded steel shapes give promise of saving considerable quantities of steel as well as time and money in producing

defense goods which are to be needed in ever increasing quantities. Even sand castings have been improved, as far as accuracy and finish are concerned by new core making methods.

An interesting development in heat treating is a process which has tentatively been designated "liquid flame hardening." By this method, steel parts are selectively hardened in a salt bath. Steps likewise have been taken to make possible the bright carbonitriding of large steel parts.

Fabricators of aluminum greeted with great interest the announcement that aluminum could be directly plated with chromium by means of a high-speed bath. Providing a hard, wear resistant surface on aluminum should help considerably in providing light weight war material. Also designed to make aluminum more wear resistant is a new chemical process recently announced by an aircraft company.

Induction heating is usually thought of primarily as a means of melting or hardening metals. Now an enterprising engineer has utilized the inherent characteristics of the process to dry finishes on metal goods. The last year has seen the widespread use of chromium plating on stainless steel automotive parts. Plating is done chiefly to provide a color match, but in some cases the plated surface protects the steel from surface discoloration.

A welding innovation that might be important in speeding defense production is a process known as contact welding. A Dutch development, the method permits good welds with inexperienced labor and, additionally, is considerably faster where applicable.

The developments mentioned in this introduction are just some of the highlights of 1950. For more complete details and a more comprehensive review, the remainder of this section has been departmentalized.

Irons and Steels

Iron and steel developments during 1950 were, for the most part, the result of seeking answers to specific problems. Though not specifically intended for war production, many of the developments will undoubtedly contribute to the stream of defense goods soon to be pouring from our factories.

High Temperature Alloy

Typical is a new iron-base alloy called Discaloy, produced by Westinghouse Electric Corp. The alloy is intended for use in aviation gas turbines and, therefore, was developed to provide high creep strength, good ductility and high resistance to oxidation in the temperature range 1000 to 1350 F. Because Discaloy successfully resists plastic flow, it is possible through its use to materially reduce the weight of gas turbine disks, thus raising efficiency without sacrifice of service life.

Discaloy is basically an iron-nickel-chromium alloy containing no columbium, cobalt or tungsten. The alloy derives its strength through heat treatment, rather than through cold working, as is the case with the majority of commercial alloys now used for aviation gas turbine disks.

The hardness of Discaloy depends upon the titanium content, and ranges from between 130 and 170 Bhn in the solution heat-treated condition, up to between 302 and 400 Bhn in the fully heat treated condition. The latter hardness range is generally restricted to forged parts. Statistical analysis shows that 95% of the heats processed into gas turbine disk forgings will have tensile strength over 130,000 psi, a 0.2% yield strength over 85,000 psi, and elongation over 15%. These minimum values are guaranteed. Average values are higher.

Discaloy has forging characteristics similar to medium carbon steel and 18:8 stainless, although it is somewhat more resistant to deformation. The alloy can be forged at from 1600 to 2300 F, although the top forging temperature is usually about 2150 F. Machining can be done with high-speed steel or cast alloy cutting tools. Early tests indicate that Discaloy can be welded without difficulty.

The new Westinghouse alloy can be used for many parts where high strength is required at temperatures up to 1350 F. Its properties recommend it for large, complicated forgings. In addition to many gas turbine components, Discaloy is used in turbo generator rotors, extrusion dies, and even as a spring material.

Low-Carbon Stainless

Although available for a few years, 1950 saw the coming into prominence of the extra-low carbon stainless steels. Stainless grades 304, 316 and 317 are all available with a maximum carbon content of 0.03%. The low carbon stainlesses are intended for those applications where intergranular corrosion might be a problem. Carbide precipitation as a result of welding makes ordinary stainless steels susceptible to such corrosion. Therefore, when welding was involved, the fabricator was required either to anneal the assembly after welding, to redistribute the precipitated carbides, or select a more expensive stabilized stainless.

Competent investigations showed that the low carbon stainless steels can be used for applications including welding, where short periods of heat exposure are involved. Low-carbon stainless and columbium stabilized stainless have been tested for corrosion simultaneously in the as-welded condition with equal results. Likewise, the corrosion resistance of the as-welded low carbon grades is

Unusual in design is this copper-brazed crankshaft which makes use of punch press and screw machine parts. (Courtesy Technical Metal Processing Inc.)

equal to corresponding regular carbon grades in the welded and annealed condition.

Although the low carbon stainless steels do not become sensitized upon short exposure to heat, they cannot be used where sustained high temperatures are involved if intergranular corrosion is to be avoided.

Generally speaking, the mechanical properties of the low-carbon stainless grades are substantially the same as for standard grades of the same type.

Many users of stainless found the low-carbon stainless steels to be extremely welcome during the final months of 1950 when government directives limited columbium stabilized stainless steels to only the most urgent uses as a means of conserving our supply of columbium.

Television Alloy

Also in the realm of stainless steel is a new alloy developed particularly to provide a stainless to replace the glass envelopes used in television tubes. When metal tubes were first introduced, a 28% chromium stainless steel was selected because its thermal expansion characteristics closely matched those of the glass screens to which it was sealed to form complete tubes.

However, 28% chromium stainless steels are expensive, so a substitute was sought. The result is a 17% chromium steel with expansion characteristics that work satisfactorily with steel. In addition to being less expensive, the new TV alloy is more easily formed than the original 28% chromium stainless.

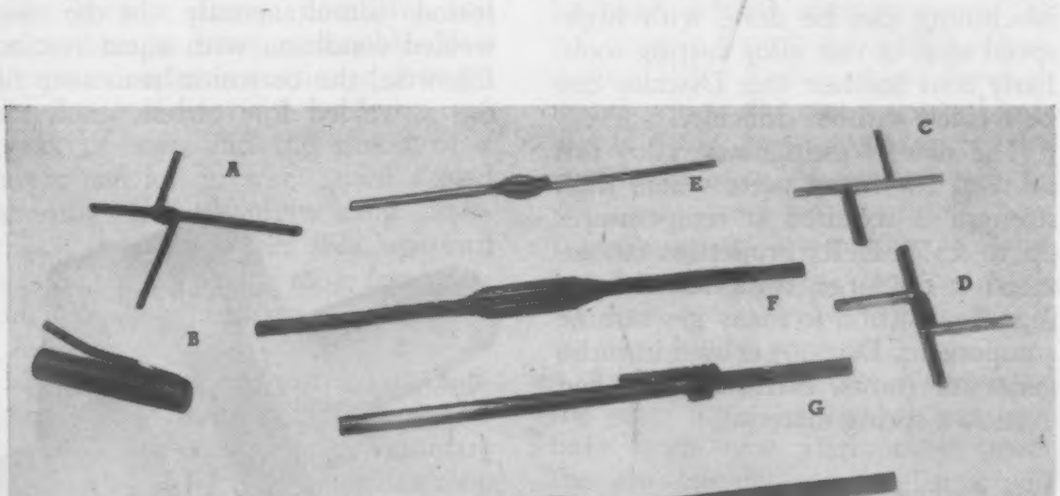
The war outlook resulted in another slight change in stainless steel compositions. At least one producer has substituted sulfur for selenium in Type 303 stainless. The element used to make the steel free machining is more urgently needed for electronic equipment and faces the prospect of being restricted to defense uses only.

New Plate Steel

Late in the year a new alloy steel known as Carilloy T1 was introduced by Carnegie-Illinois Steel Corp. The alloy is intended chiefly as a plate steel, and is said to have excellent ductility and toughness even at subzero temperatures. The new steel is suited to applications requiring high strength and good weldability. It is a multiple alloy in which carbon is held to 0.18 max.

When heat treated, Carilloy T1 provides a minimum yield strength of 100,000 psi, almost double the strength of the high-strength, low-alloy steels and three times that of ordinary welding grades of structural steel. It is anticipated that considerable materials savings can be made in applications calling for heavy steel members of ½-in. thicknesses and up.

Carilloy T1 can be welded without special preheating or postheating, and welding does not affect the alloy's properties adversely. The alloy can be fabricated by standard equipment, if sufficient power is available. Principal use of T1 appears to be in the manufacture of ships and heavy mobile equipment, including such products as earth moving and surface mining machinery. The steel is now available only as plate, but might appear later in other forms.



Last year saw an increase in the use of cold welding for such applications as joining electrical conductors. (Courtesy Koldweld Corp.)

Powdered Metals

Two new materials for powder metal parts came to the attention of American industry during 1950.

The first is a new electrolytic iron powder which has the purity inherent in that type of powder plus the shape of Swedish sponge iron. The new powder is said to compact readily because of the particle shape and ductility. Sintering can be accomplished at temperatures somewhat lower than those ordinarily used. Good results are obtained from 1300 F up, as compared to the 1500 to 1800 F normally required.

Particle size is uniform as it is controlled in the original production rather than through reduction by mechanical means. Finally, excellent electrical properties are provided in the final compacts due to close control over densities.

Ordinary cast iron or steel scrap borings or turnings are used as raw material for the powder making process. Purity of the final powder is said to be about 99.8% iron. It is to be priced competitively with standard iron powders and can be used wherever iron powders are now used.

The second development in powders is a new type of stainless steel powder which offers green strength much superior to previously available stainless steel powders. The advent of a high green strength stainless powder will help overcome one of the principal objections to the use of stainless as a raw material for powder metal parts. Still in the development stage, the two compositions of powders thus far investigated indicate that strong stainless steel powder parts can be made.

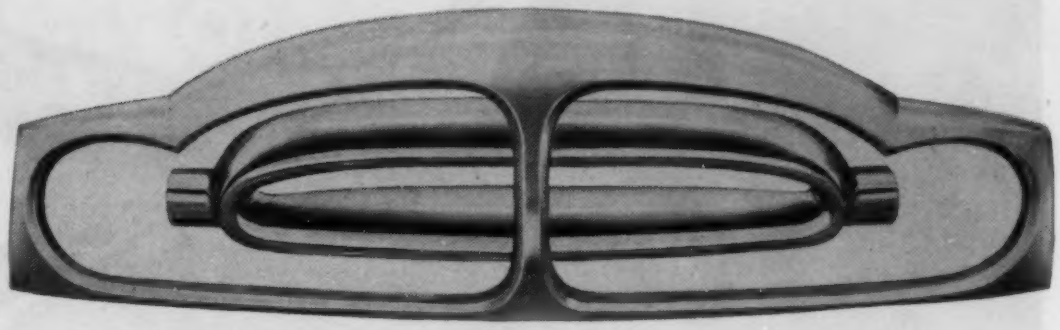
Galvanized Sheet

Destined to have widespread application in many fields is a galvanized sheet steel made available more widely early in 1950. The unique feature of this coated steel is that it retains its corrosion resistance after forming even when the forming involves deep drawing. Of course, the sheet cannot be welded or machined and still retain the coating, even though severe deformation will not cause the zinc coating to peel.

The secret of the product lies in the method of cleaning the strip steel, passing it through a reducing atmosphere in a furnace and then through

a bath of molten zinc of a controlled composition. The method of producing the zinc-coated sheet is patented by Armco Steel Corp., which has produced the material for some time. The process is now available for license to other producers.

In addition to the developments listed in the preceding section, the use of irons and steels has been improved by developments in the fields of finishing, joining and heat treatments. It is suggested that those sections of this review be studied.



Die castings continue to increase in size and complexity. The automobile grill shown here is a zinc die casting measuring 60 in. in width and said to be the largest such part ever die cast. (Courtesy Doehler-Jarvis Corp.)

Nonferrous Metals

In the field of nonferrous metals, 1950 brought forth many developments that resulted in new materials from which engineers can now choose. Of most spectacular interest has been the introduction of old metals in new ductile form. Metallic elements, once used chiefly as alloying elements, or as in the case of chromium for plating, are now being produced as sheet, bar, wire and tubing. Included in the new ductile metals are the previously mentioned chromium, vanadium, zirconium and new titanium-base alloys.

Ductile Vanadium

Electro-Metallurgical Div., Union Carbide & Carbon Corp. announced late in 1950 that limited quantities of high-purity, ductile vanadium metal were available for experimental use. The metal averages better than 99.8% vanadium, and is being produced in ingots, bars, sheet, foil and as chips for remelting.

Pure vanadium has good corrosion resistance, excellent ductility and high tensile strength. Corrosion tests show the metal to be high in its resistance to salt spray and sea water as well as to moderate concentrations of reducing acids. In addition, vanadium is reported to have good anti-fouling characteristics.

As now produced, vanadium metal has a modulus of elasticity of about 22 million psi and a density of 6.1 g per cu cm. From ingot form, it can be hot rolled at temperatures between 1475 and 2100 F by following the practices established for austenitic stainless steels. The metal does not work harden to any great extent during cold working and has been rolled down to 0.020-in. thick foil. Tests show the material to be capable of a reduction of 85% without the necessity of annealing.

Machinability of vanadium metal is comparable to cold rolled steel, and good surface finish is attained through the use of high cutting speeds. Usual practice is capable of forming, bending and stamping the metal. Welding has been done satisfactorily by using the Heliarc process with argon as the shielding medium.

Definite uses and potential applications have not yet been established for vanadium metal, but it is certain to find a place where its special properties can serve to advantage.

Chromium Sheet

The U. S. Bureau of Mines, which has done considerable developmental work on the newer metals, is responsible for the production of ductile chromium sheet. As with vanadium metal, no special applications have appeared for sheet chromium, but experimental work is going forward.

Indications are that chromium sheet is not suited for highly stressed parts which must function at room temperatures or above. The metal resists the action of hydrochloric acid and, in fact, it is difficult to dissolve in that action. The metal tarnishes slightly when heated above 1832 F. It is easy to machine if it is not subjected to bending, and has a hardness of about 60 Rockwell C.

Chromium sheet has been bent and cut when heated above 932 F in Bureau of Mines experiments.

Ductile Zirconium

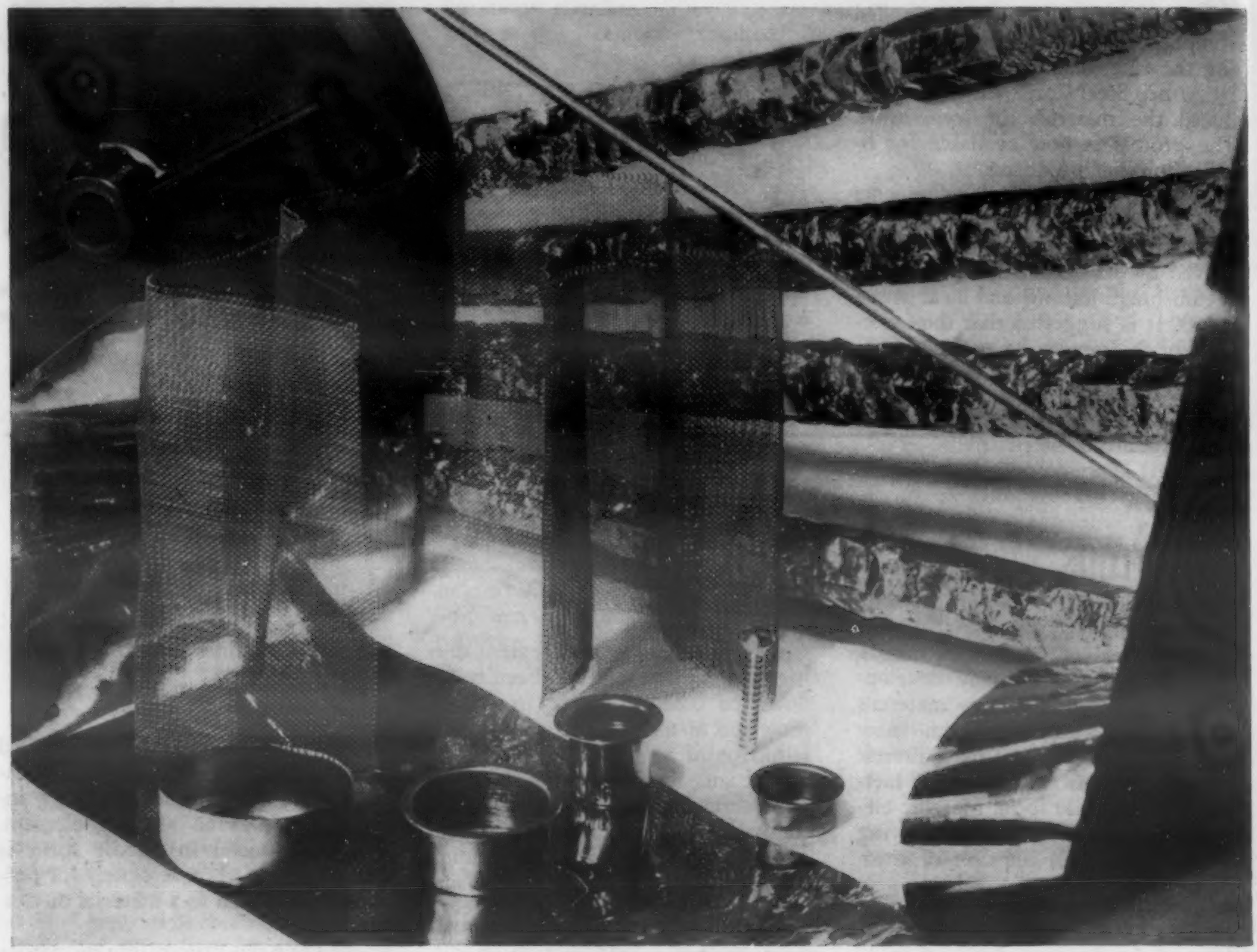
Zirconium as a metal has been used for some time in electronic applications as a getter, and is finding increased use as an alloying element. Now the metal in ductile form is being examined more closely for possible application as a material of construction.

The two most promising properties of zirconium are its high strength and excellent corrosion resistance. Its current price is too high for all but special applications. The cost of reducing the metal is great because its affinity for oxygen, nitrogen and other gases make necessary its reduction in a vacuum.

An interesting feature of zirconium is the fact that it is non-toxic and that human tissue can grow to it. This characteristic suggests its use for surgical parts and appliances, such as bone screws, plates, wire and other forms for use in the human body. The metal is used in the making of metal-to-glass seals such as would be required in making glass-lined steel tanks. Zirconium oxide is soluble in glass.

At room temperature, zirconium is moderately strong, but strength falls off rapidly at higher temperatures. Annealed zirconium has an ultimate strength ranging from 34,000 to 45,000 psi and a yield strength of from 11,000 to 20,000 psi. In weight, zirconium falls somewhere between titanium and iron and steel.

The metal, which is produced as wire, sheet, bar and rod, can be cold



Zirconium is one of the newer ductile metals. Shown here are some of the forms in which the metal is available as well as some parts made from it. (Courtesy Foote Mineral Co.)

rolled and drawn, welded by the inert gas method, and machined about like brass.

After several years of investigation, metallurgists are now bringing out alloys of titanium which seem to offer optimum properties. One of these alloys, introduced by Rem-Cru Corp., uses manganese as the alloying element. Compositions vary somewhat in the sheet alloy and the one used for bar and forging purposes.

The sheet material, which contains 7% manganese, offers a yield strength of 130,000 psi minimum. The forging and bar alloy contains only 4% manganese, but also has 4% aluminum.

Other alloying developments in titanium have been brought to a state approaching perfection, but since the metal is being used largely for military applications, information in most cases is classified as secret.

Aluminum Alloys

Aluminum, which is again taking the spotlight due to a vastly expanded military aviation program, also came in for development and improvement during 1950.

Alcoa recently announced Alloy 62S, which is similar in composition and properties to 61S. It offers, due to a reduced chromium content and finer grain size, improved formability. The newer alloy is expected to supplant 61S in many marine applications.

Advantages claimed for 62S include:

- Better appearance, achieved by finer grain size.
- More uniform spring-back during forming in the T-6 temper condition (solution treated and aged).
- Lower yield strength and slightly better workability in the annealed condition.

A new high-strength aluminum casting alloy also made its debut in 1950. The alloy, known as Almag 35, has exceptional good strength and ductility and, therefore, does not require heat treatment. The alloy's properties are developed immediately upon solidification, without any age hardening or other processing being necessary.

The alloy provides tensile strengths of from 37,000 to 42,000 psi; yield strength (0.2% set)—17,500 to 20,000 psi; and elongation (in 2 in.) –10 to 15%. Properties of the alloy remain almost constant from –76 to +225 F.

Although the basic alloy was developed for sand casting, modifications have been made for permanent mold and die casting.

In addition to its uses for many types of mechanical parts, Almag is used for ornamental purposes, because it takes a high polish which is almost mirror-like in appearance.

Again, the developments listed here are only the highlights of progress that were made during 1950. Some additional changes in processing and finishing will be discussed in the following sections of this review.

Nonmetallic Materials

For the past few years there has been an insistent demand for nonmetallic materials for such applications as gasketing, which would resist temperatures much higher than could be used with existing materials.

High Temperature Silicone

A new silicone material developed by Dow-Corning Corp. and announced late in the year comes at least a step closer to meeting the high temperature requirement. As a matter of fact, Silastic 250 retains its properties at both high and low temperatures that exceed former limits by a wide margin.

The new silicone elastomer equals, in elongation, the best values yet obtained in silicone formulations, and combines the high degree of stretchability with a tensile strength equal to the best of the high-strength formulations. In addition, abrasion resistance and tear resistance are much superior to those properties in general-purpose silicone stocks.

The established service range of the new silicone has been given as –100 F up to 500 F, but the material has been used where short time exposures of 600 to 700 F have been encountered. Properties of the silicone material are somewhat less than those of natural or synthetic rubbers within their usable temperature range. As with other silicones, resistance to hydrocarbon solvents such as gasoline, toluene and xylene is poor. The silicone swells during contact with hydrocarbon. Evaporation of the hydrocarbon solvent permits the material to return nearly to its original state and properties.

Because Silastic 250 retains its strength and flexibility under extremes of temperature beyond that at which any other elastomer will perform, it has attained several airplane applications. The uses include duct seals for jet engines where temperatures vary from –90 F up to 450 F; gaskets to withstand hot oil and tem-

peratures to 450 F; bomb bay door seals, boots protecting electrical instruments, housing seals, and many others. For some of these, silicones are the only materials that can be used.

The material can be extruded, molded, calendered or sheeted.

A silicone rubber, similar in many respects to Silastic 250, is now being produced in sponge form. As sponge, the material can be used as a vibration dampener and for fairing strips, seals and gasketing. The silicone sponge can be furnished in sheets or as special extrusions and molded shapes.

Shock Resistant Styrenes

Plastics, too, moved forward during 1950 to entrench themselves more firmly as engineering materials. One of the most important of these developments has been effective in making polystyrenes even more widely usable than they were originally.

A disadvantage of polystyrenes, in the past, has been their limited resistance to shock. Parts with thin sections were likely to be brittle. Recently at least two producers of polystyrenes have announced formulations that have impact resistance equal to that of the cellulosics. Providing the material with better shock resistance has cost the loss of some clarity in the product.

In general, the newer polystyrenes have these characteristics: good rigidity, excellent impact strength, good fabricating possibilities, excellent electrical properties, low water absorption, and low specific gravity.

The new plastics, known as Styron 475 and Plexene TA, are both formed by injection or compression molding or by extruding. They are especially suited to large area moldings such as refrigerator parts, housings for electrical appliances, and luggage; to pieces requiring high impact resistance such as safety goggle frames, industrial tote boxes, pens, pencils, battery cases, radios and flashlights.

Plastic-Fiber Material

During 1950 a new class of material came in for attention—a material that fits between laminated plastics and vulcanized fibers. The material, whose family name is Duroids, has a cellulosic base with various combinations of resin binders. The Duroids come in 48- by 60-in. sheets in thickness of from 0.015 to 0.125 in. Because the fibers in the Duroids are interlocked so tightly, the material is homogeneous and appears to be solid.

As a group the Duroids have the following properties: homogeneity, water resistance, toughness, high mechanical strength, stiffness and oil resistance. The various characteristics can be modified to emphasize one particular property for specific end use characteristics. Included in the properties that can be varied are formability, dielectric strength, heat-aging characteristics, freedom from brittleness, and others.

There are seven established groups of Duroids, with others under development. Most of the materials have a high scrap reclaim value, since scraps can be reprocessed.

The materials can be blanked, punched, slit or sheared, as well as stitched, stapled or riveted. Forming can be done on either punch or hydraulic presses.

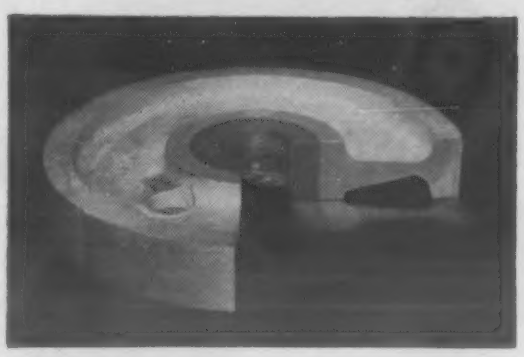
Some of the uses already found for various Duroids include structural electrical insulators, flashlight lens gaskets and electrical fitting insulation.

Plastic Rubber Blend

Another interesting nonmetallic innovation of 1950 is Enrup, a product of U. S. Rubber Co. which is best described as a thermosetting plastic-rubber blend. It is expected that the material will compete with hard rubber as well as with nylon and the phenolic plastics for many applications.

Enrup is resistant to abrasive and chemical attack and can be so varied in properties that it ranges in flexibility between that of soft rubber at one extreme and brittle, hard rubber at the other.

The material has demonstrated good resistance to oils, solvents, acids and mild alkalis. It has a heat distortion temperature of 190 F, but it will retain its dimensional stability up to 250 F and higher.



The constant shift of products from one material to another is illustrated by this automotive camshaft timing gear blank. Formerly made of plastics, which had in turn replaced metals, the part is now made of aluminum alloy with a steel hub bonded in by the Al-Fin process.

The development of low-carbon stainless is valuable in saving scarce alloying elements.

Enrup is made available in sheet, rod and tube forms as well as in gear blanks and as molded parts. Forming methods include rubber press molding, compression molding, transfer molding, sheet molding and fabrication from sheets.

The plastic-rubber material has been used extensively for high-strength, low-cost gears, in many types of equipment, including heavy-duty lathes. Due to its resistance to the new types of synthetic detergents, Enrup is superior to metals for many washing machine parts. Anticipated large scale uses include, fuel pump parts, battery cases, dies and jigs, valve seats, tote boxes, bearings, and many others.

Plywood Freight Cars

A final development in the field of nonmetallics is the development of a new railroad freight car fabricated of plywood. Designed originally to save weight, cars made of plywood can now serve to save thousands of tons of steel during the next few years.

Under recent tests the new car proved superior in many ways to the standard steel cars. The plywood car suffered from road shock much less than a steel car to which it was coupled. Superiority was also claimed in thermal tests.

The plywood used in freight car construction is a cellular laminate made by laminating strong plywoods grain against grain with special high strength plastics.

Although the cars have not yet been accepted by the Association of American Railroads, it is probable that they will be. If that is the case, fantastic savings in steel, time, money and manpower can be expected in the freight car program which has already been announced.

Fabricated Parts and Forms

As economic conditions put a greater premium on finding ways to reduce machining and finishing costs, enterprising engineers keep ahead of the move by developing better and more accurate methods of producing parts for industry.

The last year was no different in this respect than each of several years previous. Die castings were made in larger sizes and in more complicated shapes than ever before. Precision castings and powder metal parts were improved as to dimensional accuracy and finish, and, particularly in the case of metal powder parts, capable of assuming more difficult roles in engineering applications.

Hot Steel Extrusions

For many years engineers have sought ways to make steel shapes other than casting, rolling and forging. What they seemed to be looking for was a means of hot extruding steel in much the same manner as irregular cross-sectional shapes are made from many nonferrous metals.

During the last war we learned that German armament makers were extruding shell cases and similar products. Subsequent investigation by teams of U. S. engineers learned the secrets of the process and then improved upon it. Even though the cold extruding process will be used widely here, there was still something to be desired because limitations of cold extruding will permit the production only of tubular shapes with regular sections.

Early in 1950 a report came from France of a method of hot extruding steel which promised to fill the long-felt need. Already several companies in the United States have investigated the method, and at least one has completed licensing arrangements to produce steel shapes by means of the French process.

As far as can be learned from information released publicly, the hot extrusion process is almost identical with the process generally used in extruding brass, aluminum and magnesium. Success of the process is believed to be centered about the method of lubricating the hot steel.

Thus far, hot extruding has been used on molybdenum stainless steels, refractory alloys, creep resisting alloys, high-speed steels, chromium-carbon tool steels and bearing steels. Because work is done in a few seconds in extruding, uniform mechanical characteristics are imparted to the entire length of the extruded shape. High pressure applied from three directions makes possible the forming of some alloys that are difficult to forge.

In addition to forming odd-shaped tubing with internal or external fins and projections, hot extruding has produced a wide range of solid shapes, including T-'s, channels and complex shapes such as the solid from which double-barreled shot guns are produced.

Here are some applications:

Extruded conveyor chain links proved stronger and more uniform than those previously used which had been cut from steel bars that had been hot-rolled and drawn.

Pouring channels had been made by planing a block of steel, but the shapes tended to deform when subjected to heat. Extruded and drawn channels overcame this problem, apparently because of a superior longitudinal fiber structure.

Tubing, rectangular on the outside and circular inside, as well as with a varying internal diameter are among other products that have been or are being made.

New Casting Process

One of the long-time disadvantages of sand castings for many applications has been their lack of good surface finish and comparative lack of dimensional accuracy. A new development has done much to overcome these objections.

Known as the Croning, or "C" process, the new casting technique makes use of thermosetting phenolic plastics as sand binders in the molds. The casting method can be used for the production of castings in aluminum, brass, bronze and some ferrous alloys. Good surface finish and close dimensional tolerances are easy to achieve.

Productivity under the new method compares favorably with standard sand casting practice, but, in addition, thin sections can be cast (down to 0.010 in.); machining on castings is considerably reduced if not entirely eliminated; too, cleaning is simplified and, in many cases, shot blasting becomes unnecessary; and, finally, a higher yield of metal in sound, usable castings is achieved than is normal.

Molds are actually poured around hot metal patterns and, because of the plastic action, set to the shape of the pattern. The molds are thin and even, and have good strength and rigidity.

Experience with the process shows that it can be used successfully on gray iron, but that it is best suited to the nonferrous alloy. Indications are that parts such as valves, fittings, plumbing goods and Diesel engine castings where runs are long are best suited to production by the "C" process.

New Press Forming Method

A new metal forming method that turns out superior quality stampings economically on comparative short runs was unveiled during 1950. Known as Marforming, the process combines the forming capabilities of a steel die with the inexpensive tooling of the Guerin rubber pad process.

The Marform method uses a male punch similar to that used in the Guerin process, but does not require a female die, pressure plate or draw ring—saving about half the tool cost.

Forming punches can be made of Masonite, for extremely short runs; cast Kirksite for longer runs; and steel for heavy production runs. Here are some claimed advantages for the process:

1. Maintains uniform wall thickness from blank to finished part.
2. Several shapes can be formed at the same time in one press.
3. Permits deeper draws than are possible by conventional methods.
4. Allows similar shapes to be made from various materials and metal thicknesses with only minor tooling changes.
5. Sharp tapers can be formed without metal wrinkles.

Marforming was developed by Martin Aircraft engineers primarily for aircraft parts, but its use is expected to extend to many other industries where deep drawn shapes are commonly used.

Finishes

In man's eternal fight against corrosion and wear, there has been a steady stream of new finishes and constant improvement in the older finishes. Many improvements were offered during 1950, among which the following seem most interesting.

Blackening Process

Both increased corrosion resistance and reduced reflectivity are inherent in a new chemical blackening process which can be used on stainless steels, cast iron and most steels. The product, which forms the basis of the chemical bath, is known as Perma-black. One of its chief advantages is that the bath operates at moderate temperatures and without objectionable fumes.

Uses developed thus far for the process include blackening metal television tubes to prevent light bounce and the blackening of piston rings to add to their service life under severe corrosive conditions. Salt spray tests indicate that the blackening will add considerably to the life of ferrous parts under sea atmospheres.

Mica Base Paint

Products that must stand outside in all kinds of weather for years with a minimum of service present difficult finishing assignments. One solution to the problems seems to have been arrived at by Westinghouse Electric Corp. in providing a mica base three-coat system of painting to finish distribution transformers. The paint system is designated the Coastal Finish, and is able to withstand widely diverse atmospheric conditions. Service tests show the finish to have double the life of previously used finishes.

Individual coats of the paint system work cooperatively to resist moisture penetration. The first coat has good adhesion characteristics, plus good flexibility and chemical resistance to salts, acids and alkalies. Pigments are primarily zinc chromate and iron oxide. The second coat vehicle is composed of modified phenolic and alkyd resins. These materials resist heat, oxygen, salts, acids and alkalies in concentrations generally encountered in the atmosphere. The method of drying the second coat permits it to flow after all solvent has been evaporated and thus eliminates pin holes. The pigment of the second coat is composed of mica flakes which overlap each other in the film and further ward off moisture and oxygen.

The third and final coat is composed of resins and pigments designed to withstand the elements and can be tinted any desired color. When chalking occurs, the color deepens. The final coat provides good appearance, works with the other two coats to resist oxygen and moisture, and screens the ultraviolet out of the sunlight.

After 10,000 hr of salt spray test, blisters finally appeared in a finish described; other panels exposed on Florida and California seacoasts for 18 months showed weathering on the surface, but no indications of corrosion.

Aluminum Hard Coating

Another development reported by The Glen L. Martin Co. during 1950 is a new hard coating for aluminum parts. The coating is said to make aluminum surfaces file hard and thus make that material capable of being used for parts subjected to hard wear in service. The exact nature of the process has not been revealed generally, but its properties and the characteristics of the process indicate that the surface developed is a form of aluminum oxide.

The hard coating is applied electrochemically to produce a nonmetallic, highly heat refractive surface that is strongly bonded to the base metal. Color of the coating ranges from light to dark grey, depending upon the thickness as well as the alloy to which the process is applied. Coating thicknesses range from 0.0001 to 0.006 in., with 0.002 in. being the most used.

In its early stages, the process has been applied most widely to aircraft parts such as ball and socket assemblies, gear teeth spacers, bearing races, gears, pinions, impeller blades, cams, pistons, and many others. Additional aircraft applications have been tested, and many other industries are investigating.

Other related developments of 1950 are to be found in this review's section headed: "Cleaning and Finishing."

Heat Treating

As is the case with many other highly important but relatively unspectacular processes, there has been steady progress in the field of heat treating. While much of the development has been along the lines of providing better control over temperatures and atmospheres or improvements in furnace construction, there have been a few forward steps about which we should remind ourselves.

Liquid Flame Hardening

For many years the suggestion that salt baths be used for selectively hardening steel parts was dismissed as impractical, if not impossible. However, an enterprising metallurgist decided that just such a method could be used to harden the teeth of gears used in hoisting equipment made by his company. He, therefore, proceeded to develop a workable method which proved more satisfactory than the more conventional heat treating methods formerly used.

The heart of the process is the means of suspending and rotating work in the salt bath. In the present application, four gears at a time are held in a fixture suspended above the bath in such a way as to permit only the gear teeth to be submerged in the molten salt. The gears are rotated in the bath by means of a shaft connected through a universal joint to a variable speed motor.

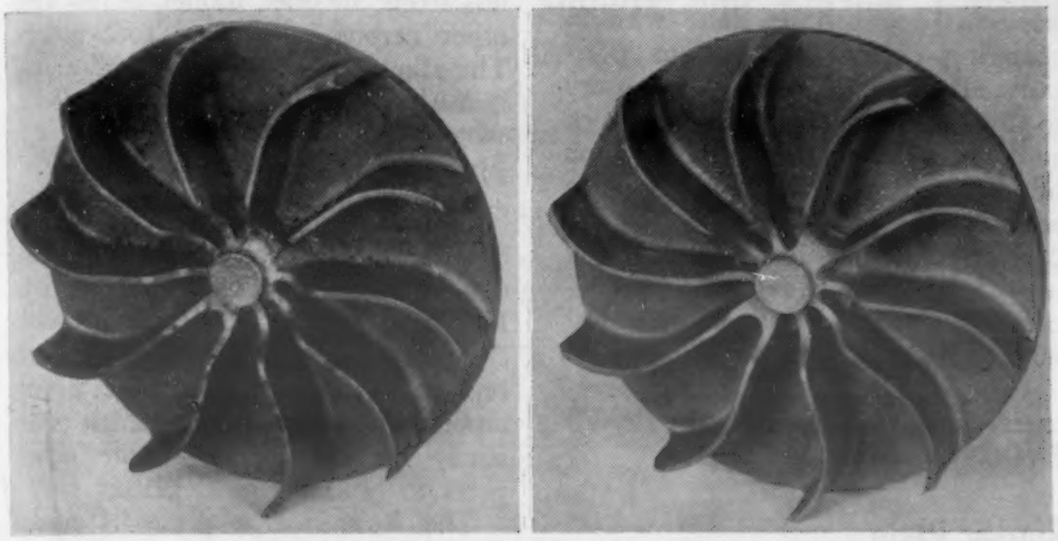
On gears made of SAE 4140 steel and having an outside diameter of 11¼ in. it has been found that a rotating speed of 40 to 45 rpm and a total heating time of 4 min are sufficient to attain the desired temperature. Salt carry-out at the selected speed is sufficient to keep the metal at temperature and protect parts from the atmosphere.

With a bath temperature of 1525 to 1550 F, quenching in oil maintained at 150 F, and tempering for

45 min at 430 F, the gear teeth attain the desired hardness of 52 Rockwell C while the tough core has a hardness of 36 Rockwell C.

Bright Carbonitriding Steel

Early in 1950 announcement was made that moderately large steel shapes could be bright hardened in a furnace that recently had been introduced. Basically, the clean surface and lack of distortion on parts treated are achieved through close control of the quenching practice. Control is provided by preventing raw air from coming in contact with the quenching oil. The quenching medium is protected by the same atmosphere that protects the work. Additionally, oil is flowed over the heated parts, rather than plunging the work into the quench. The latter feature has much to do with keeping distortion to a minimum.



Complex shapes, thin sections and good finish are all possible with the "C" casting process. The impeller casting produced by this new casting technique is shown (left) as-cast and after wet blasting.

Cleaning and Finishing

In addition to the developments in finishes reported earlier in this review, there were, naturally enough, improvements and developments in the field of finishing. During 1950 most of the more interesting changes centered upon various types of plating.

Direct Plating of Aluminum

The goal of plating chromium directly on aluminum for wear resisting applications was achieved last year through a method involving wet blasting of the aluminum surface and then plunging it directly into a high-speed plating bath. The fine abrasive suspended in water and used to clean the surfaces leaves a protective film on the aluminum and protects it from oxidation sufficiently long to permit satisfactory plating to take place. The abrasive is chemically inert and falls harmlessly to the bottom of the plating bath.

The method has been used successfully on wrought, die cast and sand cast aluminum. Most recently, the method has been used to plate titanium parts for applications where severe wear is to be encountered. Plating is extremely rapid, and coatings deposited are said to have hardnesses ranging from 75 to 82 Rockwell C.

Plating Metal Powder Parts

There are many applications for powder metal parts where plating is needed for decorative purposes or other service requirements. Plating has been done on such parts in the past, but in many cases plating solutions became entrapped in the pores of the parts and later caused corrosion. Other difficulties included obtaining a uniform thickness of plated metal and completely sealing the porous surface.

Most of the troubles in plating powder metal parts have been overcome by a new method, which is based on the theory that residual plating salts are volatilized out of the pores by heat treatment rather than by washing out in water or some other type of solvent.

The process has been used successfully to plate porous iron, brass and bronze parts. The metals plated on include copper, nickel, silver, copper-nickel and copper-tin. Chromium can be used if an extremely dry atmosphere is used during heat treatment.

There are three variations of the process.

By one method, "green" unsintered compacts are electroplated, washed, given a neutralizing acid dip, if needed, then sintered in the usual manner.

In a second method, the "green" compact is given a short, preliminary pre-sinter to increase its handling strength; then it is plated, washed, acid dipped, if needed, and finally given the full sintering operation.

A fully sintered part is electroplated, in the third method, and then washed, acid dipped if required, then given a short heat treatment to volatilize residual salts out of the pores.

All three methods are used, but the third method has some advantages over the others in that additional bonding occurs between plate and part.

Induction Baked Finishes

A contest to uncover interesting uses of induction heating equipment turned up a novel use of that method of heating which might result in better finishes on many parts.

Working on the theory that the usual methods of baking enamels entrapped gases and, therefore, gave opportunity for subsequent blistering and peeling, a resourceful engineer sought a method that would reverse the normal procedure and dry from the inside to the outside. Induction heating seemed to fill the bill as far as method was concerned, because it heated the base metal sufficiently to dry the bonding paint surfaces first.

Tests on a variety of brass and aluminum hardware items which were to be enameled show that the method added considerably to the life of the finishes. Salt spray comparative tests with several competitive products showed that the induction baked finishes last almost twice as long as the best finish on the parts dried by more conventional methods.

Welding and Joining

In the assembly of metal parts, anything that will make the job simpler and which can be done easier is most welcome. Improvements in both fusion joining and mechanical fastening came to the attention of industry during 1950, including the following highlights:

Contact Welding

For the past few years we have heard of a new type of welding rod, developed in Holland, which made possible contact welding. The rods are now available in this country and many companies have had an opportunity to investigate the new method of arc welding.

Contact welding electrodes differ from those used in normal welding in that an extremely thick, steel-powder filled coating is applied to the rod. The steel in the coating serves two functions. First, the steel prevents the coating from depositing undue amounts of slag in proportion to filler metal deposited. Second, the steel powders provide sufficient electrical conductivity in the coating to establish an arc. The latter feature makes the electrode "self-starting" and automatically restarts the arc if welding is interrupted.

Arc action in the contact electrode results in a deep cup being formed in the heavy coating. The cup provides a weld deposit that is of high quality because it shields the molten metal momentarily and prevents the absorption of excessive nitrogen. The cup also prevents excessive weld spatter.

Contact arc welding is faster than conventional welding both in actual linear speed and in weld metal deposited per pass. Part of the increased speed is due to the fact that higher currents are used than with comparable standard rods. The new welding method can be carried on in all positions and can be done without changing current for various positions. Because it is only necessary to maintain contact between work and electrode, welding can be done blindly and in restricted space. In addition, the ease of welding by the contact method often permits the use of less highly skilled labor because no specific arc length is necessary and weaving is not required.

Presently, contact welding electrodes are available in the AWS E-6012-13 and E-6020 classes.

Brazing Paste

Copper in paste form is now being used in furnace brazing to provide greater speed and less waste than is involved in using rings, foil, slugs and electroplates. The paste is applied by means of special applicator guns which extrude the paste in the form of ribbons. Quantities are established by trigger settings. However, the pastes can be thinned so that application can be made by brush, spray or dip. The pastes contain residue-free noncorrosive flux in quantities sufficient to promote bonding but still leave a bright, clean surface.

Stainless Brazing Alloy

A heat and corrosion resistant alloy has been developed specifically for brazing stainless steels. Joints so made are said to be as strong as the parent metal at temperatures up to 2000 F, and surpass it as far as corrosion and oxidation resistance are concerned. The alloy can be used to braze the 300 and 400 series of stainless steels, Inconel, monel, S-590 and other carbon, alloy and tool steels. The alloy is known as Nicrobraz and is made by Wall Colmonoy Corp.

Pressed-Fit Pin

One of the most unique fastening devices yet devised is the Rollpin, developed by Elastic Stop Nut Corp. Rollpin is a self-locking pin with chamfered ends and is designed to replace the variety of dowel, pivot, tapered and grooved pins which ordinarily require keys or some other parts to hold them in place.

The Rollpin is a piece of metal rolled into the shape of a hollow cylinder with a gap or slot which parallels the axis. The pin is then driven or compressed into a hole that, by design, is smaller than the diameter of the pin. Tension exerted by the Rollpin against the walls of the hole hold it in place securely even against extreme vibration and shock.

Rollpins are made from SAE 1095 steel and Type 420 stainless. Not normally plated, the pins can be supplied in that condition. Too, they have and can be made from beryllium copper.

Testing and Inspection

In the field of testing and inspection, the most interesting new development is a method for determining surface cracks and flaws in metal parts. Known as Dy-Check, the process makes the flaws stand out in scarlet against a white background. Dy-Check can be used in production inspection, but it is especially valuable in testing parts in the field. Crankshafts, for example, can be inspected without being disconnected.

Inspection by Dy-Check can be done in from five to ten min. A red dye penetrant is applied to the surface being inspected and allowed to stand. It is then removed with a special cleaner and dye remover and replaced with a white developer solution. Action of the developer draws red dye from any cracks, fissures or openings in the surface and makes it easily detectable.

Variations of the process have been used to check 2-in. thick castings, by putting the red dye on the inside and the developer on the outside. Capillary action of the developer draws the dye through any openings in the casting.

Conclusion

In presenting this review, we have tried to make it touch upon all of the most important developments in the field of materials engineering, but have not tried to enumerate all of the hundreds of improvements which are made in any normal year.

Most of the developments described here have been covered in more complete detail in MATERIALS & METHODS during the past 12 months or will be given more comprehensive treatment in a forthcoming issue.

It is likely that these developments, important as they are, will be somewhat dwarfed by the new things to be revealed during the next year with progress and development spurred on by the needs of our defense program.

Materials & Methods

Materials Engineering File Facts

NUMBER 204
January, 1951

METHODS:
Brazing

Solders and Brazing Materials

In compiling this data an effort has been made to give a fairly representative list of available compositions and their suppliers. There are many others, and the selection has been arbitrary to a degree and does not imply that products not included are in any way inferior to those listed.

This is the first of two File Facts on the subject. The second installment will appear next month.

This table is adapted from data to appear in the book "Materials Technology for Electron Tubes", by W. H. Kohl, to be published by Reinhold Publishing Corp.

Name of Material and Supplier		% Composition	Flux	Melt. P. Deg F	Flow P. Deg F	Comments
		Fusible Alloys				
Cerrolow—105	C.D.P.	Bi 42.9, Pb 21.7, Sn 8.0, Cd 5.0, In 18.3, Hg 4.0	—	100	110	Pretinning required on all Cerro alloys. Acid Flux gives best results with bi-alloys.
Cerrolow—117	C.D.P.	Bi 44.7, Pb 22.6, Sn 8.3, Cd 5.3, In 19.1	—	117	117	—
Cerrolow—117B	C.D.P.	Bi 44.7, Pb 22.6, Sn 11.3, Cd 5.3, In 16.1	—	117	126	—
Cerrolow—140	C.D.P.	Bi 47.5, Pb 25.4, Sn 12.6, Cd 9.5, In 5.0	—	134	149	—
Cerrolow—136	C.D.P.	Bi 49.0, Pb 18.0, Sn 12.0, In 21.0	—	136	136	—
Cerrolow—136B	C.D.P.	Bi 49.0, Pb 18.0, Sn 15.0, In 18.0	—	136	156	—
Cerrolow—147	C.D.P	Bi 48.0, Pb 25.6, Sn 12.8, Cd 9.6, In 4.0	—	142	149	—
Woods Metal	C.D.P.	(a) Bi 50.0, Pb 25.0, Sn 12.5, Cd 12.5 (b) Bi 50.0, Pb 24.0, Sn 14.0, Cd 12.0	—	158	165	—
Cerrolow—174	C.D.P.	Bi 57.0, Sn 17.0, In 26.0	—	174	174	—
Bi-Pb-Cd		Bi 51.6, Pb 40.2, Cd 8.2	—	197	197	—
Newton's Alloy		(a) Bi 52.5, Pb 32.0, Sn 15.5 (b) Bi 50.0, Pb 31.3, Sn 18.8	—	203	203	(a) B-Sealing solder for wiped joints.
Darcet's Alloy		Bi 50.0, Pb 25.0, Sn 25.0	—	203	239	—
Rose's Alloy		(a) Bi 50.0, Pb 28.0, Sn 22.0 (b) Bi 46.0, Pb 20.0, Sn 34.0	—	212	212	—
Cerroseal—35	C.D.P.	Sn 50.0, In 50.0	No flux on non-metals	240	260	Low vapor pressure, adheres to glass, metal, mica, quartz (and glazed ceramic).
Alkali-Resistant Solder		Sn 37.5, Pb 37.5, In 25.0	A	274	358	Strong and corrosion resistant.
Cerrotru	C.D.P.	Bi 58.0, Sn 42.0	—	281	281	—
Bi-Cd-Eutectic		Bi 60.0, Cd 40.0	—	291	291	—
Sn-Cd-Eutectic		Sn 67.8, Cd 32.2	—	351	351	—

(Continued on page 99)

Materials Engineering File Facts

NUMBER 204—(Continued) **SOLDERS AND BRAZING MATERIALS**

Name of Material and Supplier		% Composition	Flux	Melt. P. Deg F	Flow P. Deg F	Comments
Soft Solders						
Pure Indium	**I.C.A. C.D.P.**	In 100.0	—	313.5	313.5	Very expensive, rarely used.
Alkali-Resistant Solder		In 50.0, Pb 50.0	A	360	—	Strong and corrosion resistant.
Eutectic Soft Solder		Sn 61.9, Pb 38.1	—	361	361	—
Lead-Tin Solder		Sn 60.0, Pb 40.0	—	361	374	—
		Sn 50.0, Pb 50.0	A	361	421	Works easily.
		Sn 45.0, Pb 55.0	—	361	440	—
		Sn 40.0, Pb 60.0	—	361	460	—
		Sn 35.0, Pb 65.0	—	361	476	—
		Sn 30.0, Pb 70.0	—	361	491	—
		Sn 25.0, Pb 75.0	—	361	511	—
		Sn 20.0, Pb 80.0	A	361	531	—
		Sn 15.0, Pb 85.0	—	361	550	—
		Sn 10.0, Pb 90.0	—	361	570	—
		Sn 5.0, Pb 95.0	—	518	594	—
Lead-Tin-Antimony Solder		Sn 25.0, Pb 73.7, Sb 0.96	—	363	504	—
		Sn 20.0, Pb 79.0, Sb 1.0	—	363	517	—
		Sn 34.5, Pb 64.1, Sb 1.25, As 0.11	—	363	—	E-Wiping Solder (Bell System).
		Sn 40.0, Pb 58.0, Sb 2.0	—	365	448	—
		Sn 35.0, Pb 63.2, Sb 1.8	—	365	470	—
		Sn 30.0, Pb 68.4, Sb 1.6	—	365	482	—
Alkali Resistant Solder		Pb 75.0, In 25.0	A	446	—	Strong and corrosion resistant.
Pure Tin		Sn 100.0	A	450	450	Shrinks. Cu-Sn alloys brittle. Low strength, rarely used.
		Sn 95.0, Sb 5.0	—	450	464	Sweating Cu tubing joints.
Lead-Silver Eutectic		Pb 97.5, Ag 2.5	A	579	579	—
		Pb 94.0-95.0, Ag 6.0-5.0	A	579	715	—
		Sn 1.0, Pb 97.5, Ag 1.5	—	588	588	—
	C.D.P.	Pb 95.0, In 5.0	—	598.5	598.5	—
Pure Lead		Pb 100.0	—	621	621	—
"Tec"	**H.&H.**	Cd 95.0, Ag 5.0	A	640	740	—
Intermed. Solder	**I.C.A.**	Sn 75.0, Ag 20.0, Cu 3.0, Zn 2.0	A	752	—	Allow time for Sn to diffuse.

(To be continued next month)

FLUXES

Code		
A	(1) Liquid: 40 pt zinc chloride + 20 pt ammonium chloride + 40 pt water (2) Paste: 90 pt petrolatum + 10 pt ammonium chloride (3) Solution of resin in alcohol	
B	NU Braze Wonderflux No. 4	SH
C	Handy Flux (fluid 1100 to 1600 F)	H.&H.
D	(1) 10 pt powdered borax + 1 pt boracic acid (2) Borax applied dry	
H_2	Hydrogen	
M	Marvel (1450 to 1900 F),	A.R.S.
A.P.1	Low Temperature Flux No. 1100,	A.P.W.
A.P.2	All Purpose Flux No. 1200,	A.P.W.
L_2	Handy & Harman,	H.&H.

SUPPLIERS	*Code*
American Platinum Works	A.P.W.
Cerro de Pasco Copper Corp.	C.D.P.
General Plate Div.	G.P.
Handy & Harman	H.&H.
Indium Corp. of America	I.C.A.
Sherman & Co.	SH

Original compilation by R. O. McIntosh, Westinghouse Research Laboratory, 1943.
Revised compilation by W. H. Kohl, Collins Radio Co., Research Div., 1950.

New Materials and Equipment

Materials

Polyvinyl Chloride Plastic

A noninflammable, unplasticized polyvinyl chloride plastic which can be machined, formed and welded has been announced by *American Lucoflex, Inc.*, 767 Fifth Ave., New York 22.

Outstanding properties of the new material, Lucoflex, are said to include ease of fabrication and machinability, dimensional stability, chemical resistance, serviceability, and good physical and electrical properties.

Available as a bulk resin, or in the form of sheets (from 0.01 to 1 in. or more in thickness) rods and tubing, the new type plastic is translucent in thin, and opaque in thick sections. Its specific gravity is about 1.4, and its heat resistance, like most thermoplastics, is relatively low (softening point to 177 F).

Primarily an industrial plastic, the new material is said to have proved successful in such applications as valves and pipe fittings, tank linings, fume and exhaust systems, electroplating hoods, ferric cyanide cells, bearings and gears for acid-processing equipment, and insulators.

Age-Hardening Alloys

Designed for industrial and jewelry applications, the 715 and 720 manganese age-hardening alloys announced by the *General Plate Div. of Metals & Controls Corp.*, Attleboro, Mass., are said to be easily fabricated, welded and soldered.

Both alloys are nonmagnetic and have resistance to corrosion which is comparable to that of 18% nickel silver. Because of the high electrical resistance of these alloys, they are reported to be ideal for resistance welding.

According to the manufacturer, the alloys have a wide range of application in the industrial and jewelry fields. High elastic limits and great strength have made 715 and 720 good materials for springs, diaphragms, bellows, clips, and small parts of intricate shape. The 715 alloy finds wider application in the jewelry industry, while the 720 is more generally used in industrial applications.

Priced competitively with other age-hardening alloys, these alloys are available in both solid form and composite metals, and in sheets, wire and tubing.

Hot Working Die Steel

A newly developed hot working die steel is now being marketed in the form of solid press dies, insert dies, upsetter dies, and punches by *Heppenstall Co.*, 4620 Hatfield St., Pittsburgh 1, Pa.

Although it resists the plastic flow of hot metal during press forging operations, the new steel, called Prestem, is said to develop a minimum amount of heat checking, which is the cause of fatigue failure. Other characteristics claimed by the manufacturer include ready machinability at comparatively high hardness, high impact resistance, and ability to be water cooled during press forging operations.

Prestem is marketed in three general hardness ranges:

(1) "A" hardness with a 2.95 to 3.10 Brinell ball diameter and a 41 to 45 Rockwell C.

(2) "B" hardness with a 3.15 to 3.30 Brinell ball diameter and a 36 to 40 Rockwell C.

(3) A prehardened, untempered state with a hardness range of 3.10 to 3.25 Brinell ball diameter and a 38 to 42 Rockwell C for customers' tempering after machining to a precipitation hardness beyond machinability.

When dies are tempered at 950 F by the customer, a hardness range of 2.90 to 3.00 Brinell ball diameter and a 45 to 48 Rockwell C will result. If tempering is accomplished at 1050 F, the hardness range will be 2.70 to 2.85 Brinell ball diameter and a 49 to 52 Rockwell C.

It is predicted that Prestem will be particularly useful as a solid die or insert die for those drop forge plants which produce press and upsetter forgings for the automotive, aviation and farm implement industries.

CONTENTS

Parts & Forms

Large Centrifugal Castings

New equipment to produce larger sizes has been added to the centrifugal casting department at *American Non-Gran Bronze Co.*, Berwyn, Pa.

The company now offers centrifugally

New Materials and Equipment
(CONTINUED)

Sizes of these centrifugal castings are indicated by the 1-ft scale.

cast liners, sleeves, rolls, rings, bushings, etc. in bronze alloys—rough or machined —up to 12 in. o.d. and 13 in. in length.

Electrical Insulators

All types of Teflon insulators for high voltage, high temperature, and high or ultra high frequency service in television transmitters, radio, radar, and other electrical equipment are now being fabricated by *The Teflon Products Div., United States Gasket Co.*, P. O. Box 93, Camden, N. J.

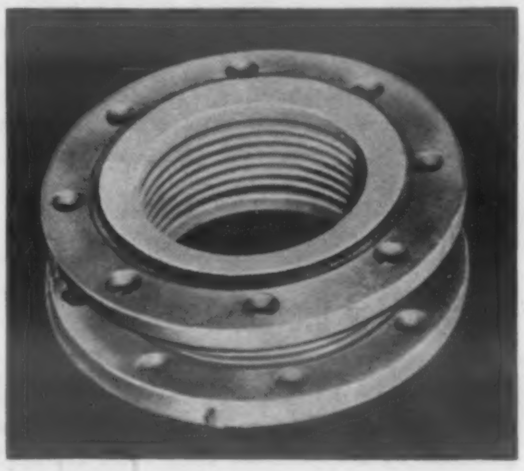
Teflon (tetrafluoroethylene resin) is said to have a power factor of less than 0.0005 and a dielectric constant of 2.0 over the entire frequency range in use today. It has excellent dielectric and mechanical strength and, according to the manufacturer, is serviceable throughout a temperature range from -90 to 500 F.

Teflon is said to be tough, resilient, chemically inert, has zero water absorption, and is unaffected by outdoor weathering.

These Teflon insulators are among the many different kinds now being produced for electrical applications.

Expansion Joints

New expansion joints now being manufactured by *Teflon Products Div., United States Gasket Co.* P. O. Box 93, Camden, N. J., have been designed for use where thermal expansion, vibration or other conditions demand a flexible, chemical-proof piping section.



This Teflon expansion joint is completely impervious to chemical attack.

Fabricated by a special process, these tough, heat resistant, solid Chemiseal Teflon joints are reported to accommodate axial contraction and expansion or any reasonable amount of misalignment or vibration without danger of cracking. Impervious to chemical attack, the expansion joints are designed for 125-lb pressure and are serviceable throughout the temperature range from -150 to 400 F.

Available for all types of equipment and for a wide variety of operating conditions, the new joints are normally supplied with suitable integrally-gasketed flanges drilled to 150-lb ASME standard.

Neoprene Covers

Barrel and drum covers of tough Neoprene-impregnated paper are now being manufactured by *Chase Bag Co.*, 309 W. Jackson Blvd., Chicago 6.

Manufactured from special paper—heavy, creped kraft containing a small percentage of Neoprene synthetic rubber—the covers are made by combining Neoprene latex with paper pulp. The Neoprene, it is said, adds greatly to the finished paper's wet strength, and imparts resistance to sunlight, oils and chemicals.

●

Coatings & Finishes

Protective Coating Base

A new baking-type intermediate coating that is expected to form a versatile base for a whole new field of protective coatings has been developed by the *Chemical Dept., General Electric Co.*, Pittsfield, Mass. Designated as R-108, the new coating base is said to combine outstanding chemical resistance with flexibility and heat resistance.

According to the manufacturer, the new intermediate is compatible with a variety of coating resins. Protective coatings formulated with it possess the characteristics of the intermediate, which include resistance to alkalies, acids, oxidizing agents, solvents and salts.

Designed to permit formulation of coatings that combine the outstanding properties of both vinyl and conventional phenolic coatings, R-108 is expected to be especially useful as a coating for drums, food containers, tank cars, chemical tanks and process equipment appliances.

Standard equipment and conventional techniques can be used for applying and baking these new coatings.

Impregnating Varnish

Frederick S. Bacon Laboratories, 172 Pleasant St., Watertown, Mass., have developed a new impregnating varnish which is said to withstand temperatures as low as −70 F without cracking.

Called ABC Impregnating Varnish, the new oil-resistant product was developed to meet low temperature requirements in aeronautical and military electronic applications. The physical properties of the varnish applied to brass strips and cured one hour at 150 F and another hour at 212 F are indicated by the following data:

1. No change in appearance after a 48-hr immersion in chlorinated diphenyl, Acryloid Resin dissolved in dioctyl sebacate, petroleum-base lubricating oil, or fluorocarbons.
2. No change after cold crack test of 15 min at 150 F, 15 min at -70 F and 15 min at 150 F, and 15 min at -70 F.

Average electrical properties of the new


MAKE A TON OF SHEET STEEL GO FARTHER
Specify-
N·A·X
HIGH-TENSILE STEEL
... And
"MAKE YOUR PRODUCT LAST LONGER"

New Materials and Equipment

varnish include a dielectric strength (1/16 in. thick) of 500 v/mil, a dielectric constant (60 cycles) of 3.3, a power factor (60 cycles) of 0.016, and a loss factor (60 cycles) of 0.05.

Aluminum Brightening

Development of a new and inexpensive process for brightening aluminum and its alloys has been announced by *Kaiser Aluminum & Chemical Corp.*, 1924 Broadway, Oakland 12, Calif.

Kaiser Bright Dip uses a simple flow work pattern and a low acid concentration

The deep-drawn aluminum container at left has been given the Kaiser Bright Dip treatment.

bath which is easily maintained by inexpensive periodic additions of the active components to give it unusually long life. As much as 90 sq ft of aluminum surface is said to have been processed per gallon of solution with only slight additions.

According to the manufacturer, the new method enhances the appearance of all aluminum alloys, and is particularly effective on high purity aluminum.

Chief uses for the new process are brightening mill-finish sheet, brightening articles for anodizing and dyeing, increasing total reflectivity of buffed articles, and brightening articles without buffing.

Protective Zinc Coating

A new method of cold galvanizing for surface protection of steel and iron has been announced by the *Chase Chemical Corp.*, 40 W. 29th St., New York 1.

Utilizing Zinkrich cold galvanizing compound, the new process is said in many

New Materials and Equipment

cases to exceed the performance of other surface protection techniques.

Advantages claimed for the process are:

1. Zinkrich, when applied to steel or iron surfaces, creates an electro-chemical union, thus allowing zinc to become galvanized to the base metal's surface, and giving a thicker protective coating.
2. The compound provides electrical continuity through its layers of zinc.
3. In cases where the compound is applied directly onto adhering rust, it induces the rusted area to create its own protective, non-flaking coating, thus arresting further rust.
4. Zinkrich is applied directly to the surface of the object with an ordinary paint brush, electric spray gun or cold dip.

Alkyd Paint Resins

Three new alkyd paint resins designed for industrial and architectural finishes have been announced by the Chemical Dept., *General Electric Co.,* Pittsfield, Mass.

According to the manufacturer, GE Glyptal Resin 7310 is a rapid tough-baking vehicle for industrial type finishes which has excellent weather resistance and color-retention properties. It is recommended for a wide variety of metal products, including farm machinery, machine tools, gasoline pumps, and air-drying enamels.

Combining excellent adhesion, gloss and color-retention with chemical resistance, weather resistance and flexibility, a second resin, Glyptal Resin 2522, is utilized in heat resistant paints for stoves, air-drying finishes for room interiors, and home appliance paints.

The third resin, Glyptal Resin 7300, is a general purpose alkyd with improved gloss retention designed for architectural applications.

•

Heating, Heat Treatment

Electric Heat Treat Furnaces

An addition to the Temco line of heat treating and laboratory furnaces, a new wired control panel is now being manufactured by *Thermo Electric Manufacturing Co.,* 493 W. Locust St., Dubuque, Iowa.

The panel houses the temperature con-

New Materials and Equipment

troller, together with the load carrying relay, thermocouple lead, and fused disconnect switch which enables the user to merely attach it to the furnace and make two connections, one to the furnace and one to the electric line.

Either an automatic electronic pyrometer-controller or a manually operated controller-indicator can be used in the control panel. The electronic controller permits the operator to pre-set the control for required temperature, which is said to be automatically maintained, while the manual control allows the operator to regulate temperature by adjustment of the control knob.

Protective Atmosphere Generator

A new Monogas generator has been added to the line of protective atmosphere equipment manufactured by *Westinghouse Electric Corp.*, Box 2099, Pittsburgh 30, Pa.

Monogas is a non-decarburizing neutral atmosphere which consists essentially of nitrogen and small amounts of hydrogen

This new Monogas protective atmosphere generator is designed to effect greater operating efficiency.

and carbon. Carbon dioxide, oxygen and water vapor are removed. It is usually produced by scrubbing carbon dioxide from an Exogas atmosphere, a process requiring both an Exogas generator and a CO_2 scrubber.

The new Monogas generator unit is packaged to include the generator and scrubber as one unit. As a result, the waste heat of combustion in the Exogas generator is utilized in reboiling the CO_2 scrubbing chemical. This elimination of an outside heat source is said to increase the operating

New Materials and Equipment

efficiency of the unit considerably. Units are available in sizes ranging from 500 to 15,000 cu ft per hr.

Radiation Measuring Instruments

A completely integrated series of radiation measuring instruments for recording temperatures from 125 to 7,000 F has been developed by *Minneapolis-Honeywell Regulator Co.,* Wayne and Roberts Ave., Philadelphia 44.

The Radiamatic Series is said to cover measuring of temperatures in destructive atmospheres, of large surface areas, where work moves or rotates, or where temperatures are above thermocouple range. Included in the series is a low-intermediate radiation pyrometer with a calcium fluoride lens for temperatures from 200 to 1200 F, an intermediate with a fused silica lens for 800 to 2300 F, and a high pyrex lens for 1000 to 3200 F.

A low-range model chiefly for measuring moving object temperatures from 125 to 350 F is another feature of the series, while a third part is composed of a small target model for 1700 to 3200 F and a very high model for 3000 to 7000 F, for exceedingly small objects.

•

Cleaning & Finishing

Tumbling Machine

Designed with an increased capacity for grinding, deburring and finishing metal parts, a new tumbling machine is now being offered by the *Grav-i-Flo Corp.,* 400 Norwood Ave., Sturgis, Mich.

With its two 24-in. by 40-in. I.D. compartments, the new machine is rated to handle a 30% larger work load than comparable machines occupying the same square feet of floor space. Other improved features of the tumbling machine are said to include:

1. Compartments are furnished with ½-in. plate unlined or ¼-in. plate rubber lined.

2. Doors have locks with manually released safety stops to provide pressure relief.

(Continued on page 113)

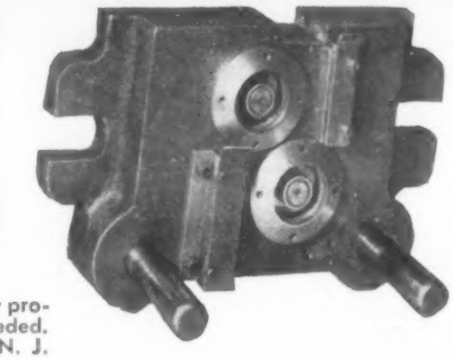
Tool Steel Topics

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation





Made from BTR oil-hardening tool steel, this die recently produced 7,953,632 bottle caps before redressing was needed. Photo courtesy of R. M. Hollingshead Co., Camden, N. J.

BTR BLANKS AND FORMS 100,000 BOTTLE CAPS IN EIGHT HOURS

High-Production Die Still Going Strong After Four Years' Service

It takes a long time to wear out a die that's made from BTR. This popular, oil-hardening grade was selected by the R. M. Hollingshead Co., Camden, N. J., for this high-production die that blanks and forms 1-in. bottle caps from tin plate in almost fabulous quantities. Hardened to Rockwell C-61, the die is redressed about every three months. Records kept by William Schaefer, machine shop foreman, show that the die recently produced 7,953,632 caps between grinds. Such results indicate good tool design, correct heat-treatment and grinding . . . and quality tool steel to fit the job.

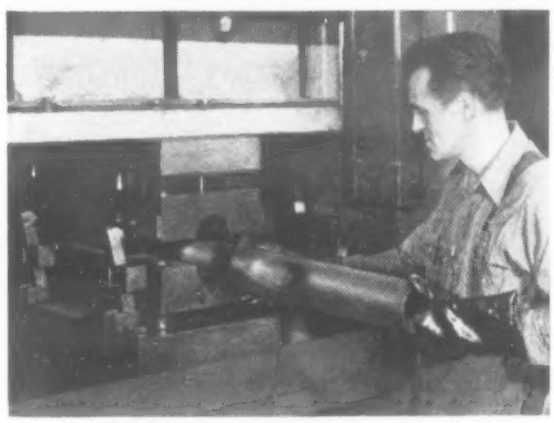
The performance record of this die over a four-year period is a good example of the long wear of which BTR is capable. Next to carbon tool steel, BTR is the most versatile of Bethlehem fine tool steels.

It's safe-hardening in oil at 1475 F. It holds close dimensions during heat-treatment, has high resistance to wear and shock. BTR is an economical grade to buy, and it's easy to machine and heat-treat. There's not much more you could ask of a general-purpose tool steel!

Our Tool Steel Engineer Says:

Reduce tool failures by removing "feather" edges

A "feather" often remains on the working edges of tools after they are ground. Especially on cutting tools, it is best to remove these irregularities. Otherwise the cutting edge will get dull or fail prematurely. The experienced shop man carries a stone in his pocket for touching up such edges, for he knows that removing feather edges pays off in longer tool life.



This die of Lehigh S puts large dents in 3-in. steel tubing which is then fitted with baffles to make an efficient flue for space heaters.

Lehigh S Solves Problem for Space-Heater Manufacturer

In setting up the production of their patented "Heat Trap" flue for gas space heaters, the Day and Night Manufacturing Co., Monrovia, Calif., needed a tool steel with the absolute maximum of wear-resistance. The design called for a series of indents in a steel flue, staggered and baffled so as to retard rising hot gases in the flue and deflect them from side to side.

Lehigh S was the logical choice. This high-carbon, high-chromium grade (2.05 pct C; 12 pct Cr) has the highest hardness of all Bethlehem tool and die grades, ranging up to Rockwell C-66. And that's *hard!* Used for the form punches and inserts at wear points for the forming die illustrated, Lehigh S has given long service, requiring no maintenance after putting indents in more than 300,000 pieces of 3-in. steel tubing.

Heavy-Duty Shear Blades Made to Your Order

When you buy Bethlehem Shear Blades you get the benefit of our many years of experience in making all our own specialty shear blades for cutting sheets, strip, billets, bars, and plates in our own plants. Making our own shear blades involved many years of special development work in tool steels, and in blade design, heat-treatment, and grinding techniques. But we developed this product because we needed better blades than we were able to purchase, blades better able to stand up under heavy shock and high wear.

Bethlehem Shear Blades are usually made from Lehigh H, Lehigh L (for better shock resistance), or Lehigh S (for greatest wear-resistance where heavy shock is not a factor). Some are made from our hot-work and shock-resisting tool steels.

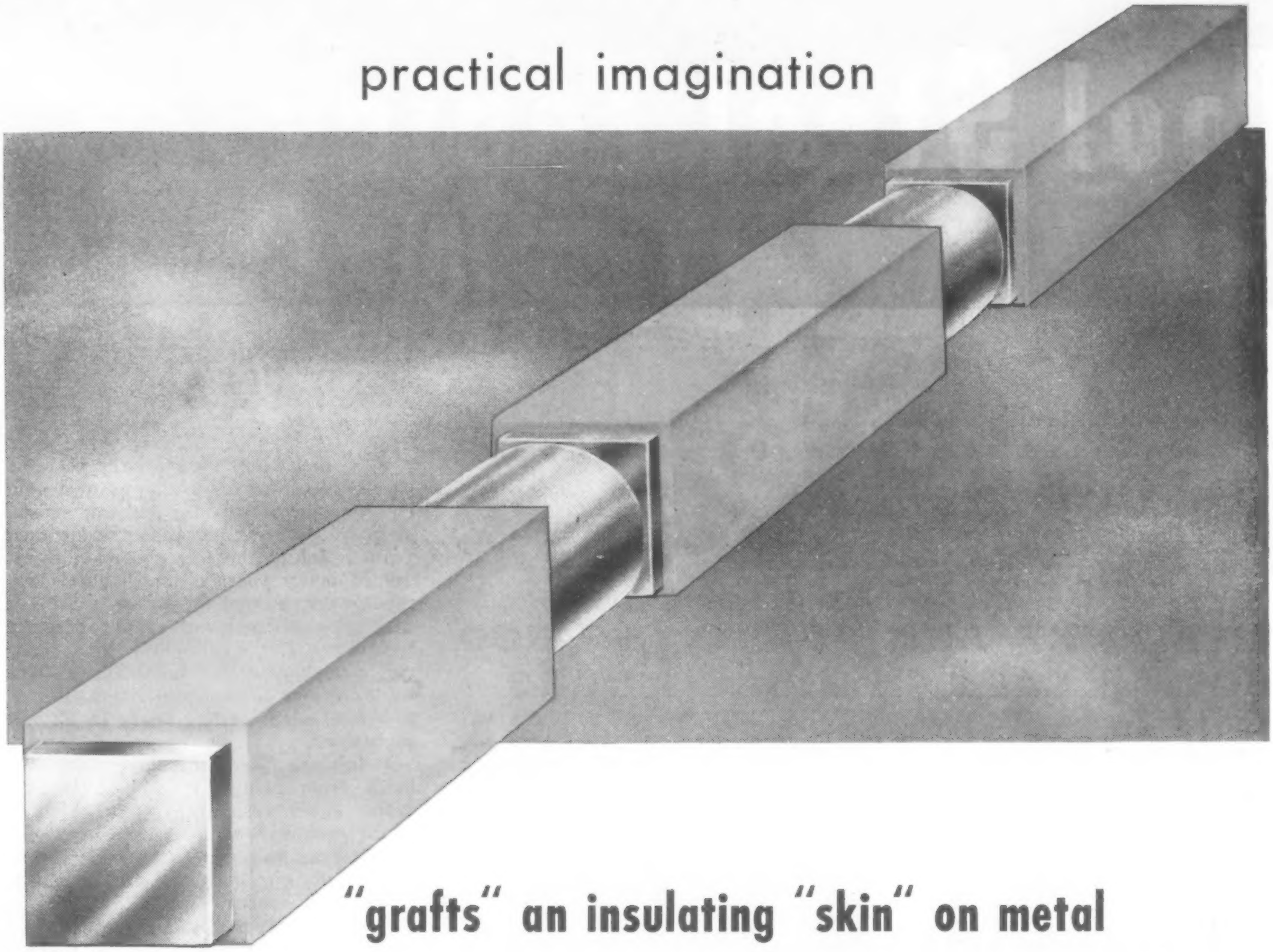
Among our specialty blades are: flying pinch knives for continuous sheet-strip mills, resquaring shear knives, heavy-duty knives for plates, rotary slitters, and many special-purpose blades.

Bethlehem blades have established fine performance records in the most severe types of shearing service. If you use blades requiring high-alloy tool steels let us tell you what we can do for you in supplying shear blades specially designed to your requirements.

Rotary slitters and shear blade made of Lehigh H, our most popular grade of high-carbon, high-chromium tool steel—for maximum production.

Bethlehem ULTRASONIC TESTED **Tool Steel**

practical imagination



"grafts" an insulating "skin" on metal

Here is another example of the practical imagination C-D engineers can put to work to solve your problems. In this case a heavy electrical connector had to be covered with a safe, efficient insulation. The material best suited to do the job was C-D Dilecto.

The next requirement was to make this insulation an integral part of the whole piece. Here is where practical imagination went to work. The solution was to laminate and mold the Dilecto directly on the metal bar.

When you have a problem involving plastics—whether it is simple or complex—be sure to check with C-D engineers for a practical, unbiased recommendation. They can choose the material best suited to your needs from a wide range of grades of five basic plastics to give you any combination of mechanical, electrical or chemical characteristics. A call to your nearest C-D office will bring you this kind of help any time—all the time.

your partner in producing better products

DILECTO (Laminated Thermosetting Plastic)
CELORON (Molded High-Strength Plastic)
DIAMOND FIBRE (Vulcanized Fibre)
VULCOID (Resin Impregnated Fibre)
MICABOND (Bonded Mica Splittings)

DE-1-51

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES.
WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK 25 DELAWARE

New Materials and Equipment

3. A limit switch on the safety guard cuts off current to stop barrel rotation when the guard is lifted.

A 30% larger work load can be handled by this Grav-i-Flo tumbling machine.

4. Water and electrical services are integral with the machine and available for instant, convenient connections.

Electroplating Addition Agent

A new and effective addition agent for electroplating baths has been announced by *Westinghouse Electric Corp.*, 306 Fourth Ave., Pittsburgh 30, Pa.

When the new agent, Wes-X, is added in small doses to cyanide copper-plating baths, the plated copper is said to be smoother, less grainy, and can be laid down at a faster rate.

Among addition agents, Wes-X is unique, according to the manufacturer, because it utilizes an inorganic metallic salt as a base instead of an organic one. The baths are claimed to be much more stable with this inorganic agent because no decomposition products build up to cause low quality deposits such as those which occur when organic agents are used.

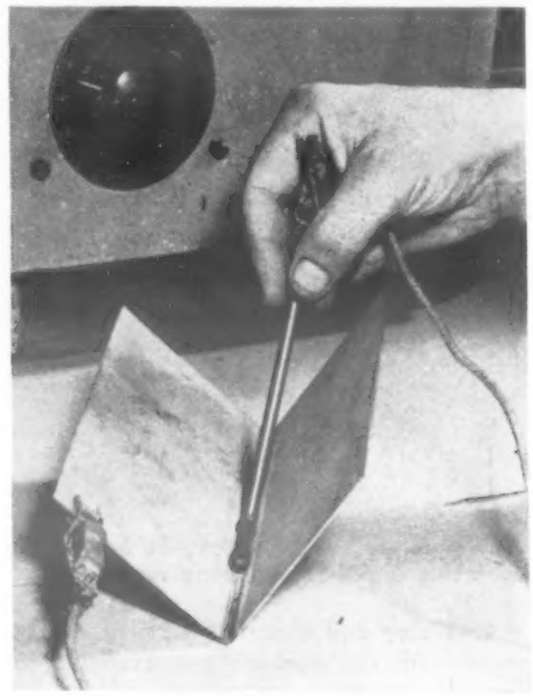
Stainless Steel Cleaner

A simple and economical method for removing weld discoloration from stainless steel has been developed by the *Research Div.* of *Armco Steel Corp.*, Middletown, Ohio.

Equipment for the cleaning method is simple. Only a battery or rectifier for d.c. power, a small amount of acid solution to cover the discolored area, wire, clips and a copper tool are necessary.

After the part is connected to the power

source, acid solution is applied to the weld area and the copper tool passed along the weld. The cleaning not only removes weld discoloration, according to the manufacturer,



This relatively simple process removes weld discoloration from stainless steel.

but passivates the cleaned area. Heavy scale or weld slag should be removed, however, by chipping or brushing before the process is used.

Chlorinated Solvent

Partial production of perchlorethelyne, an organic chlorinated solvent, has begun at the plant of the *Columbia Chemical Div., Pittsburgh Plate Glass Co.*, Barberton, Ohio.

Used as a dry cleaning and metal degreasing solvent, perchlorethelyne is classified as noninflammable by underwriters, and is said to be less toxic than some of the other chlorinated solvents.

Tin Anodes

Tin and tin alloy anodes for use in the electroplating of tin and for the new tin-zinc plating process are being manufactured by *Metal & Thermit Corp.*, 100 E. 42nd St., New York 17.

Three types of anodes are now available: Pure tin anodes; high-speed alloy tin anodes, which are said to provide increased efficiency in tin plating; and tin-zinc anodes, used for depositing a tin-zinc alloy.

New Materials and Equipment

Welding & Joining

Transformer Welder

Availability of a new 200-amp transformer welder designed to cover a wide range of applications from light duty sheet metal jobs to heavy duty industrial work has been announced by *Air Reduction Sales Co.*, 60 E. 42nd St., New York 17.

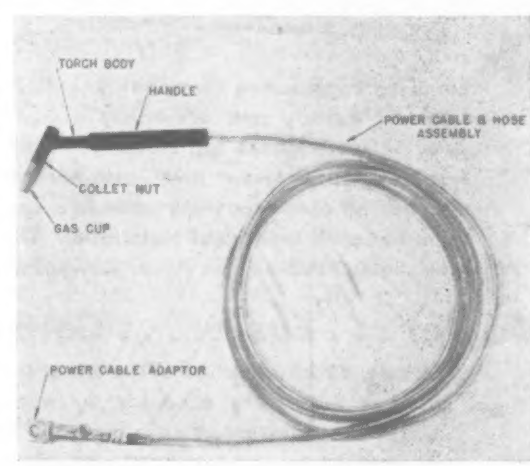
A small compact unit 12 by 17 by 23 in. high, the MCX has a full 200-amp, 50% duty cycle, NEMA rating. Three current ranges selected by insulated tapered plug connectors and infinite hand crank adjustments within each range provide currents from 30 to 250 amp.

Outstanding features of the new welder include water repellent and heat resistant silicone insulation which is said to provide a high margin of safety and an automatic hot start control with a hermetically sealed, gas-filled, time-delay relay magnetic switch that has no open contact.

Lightweight Torch

The Linde Air Products Co., 30 E. 42 St., New York 17, has announced the production of a new, lightweight, air-cooled Heliarc torch for inert gas-shielded arc welding.

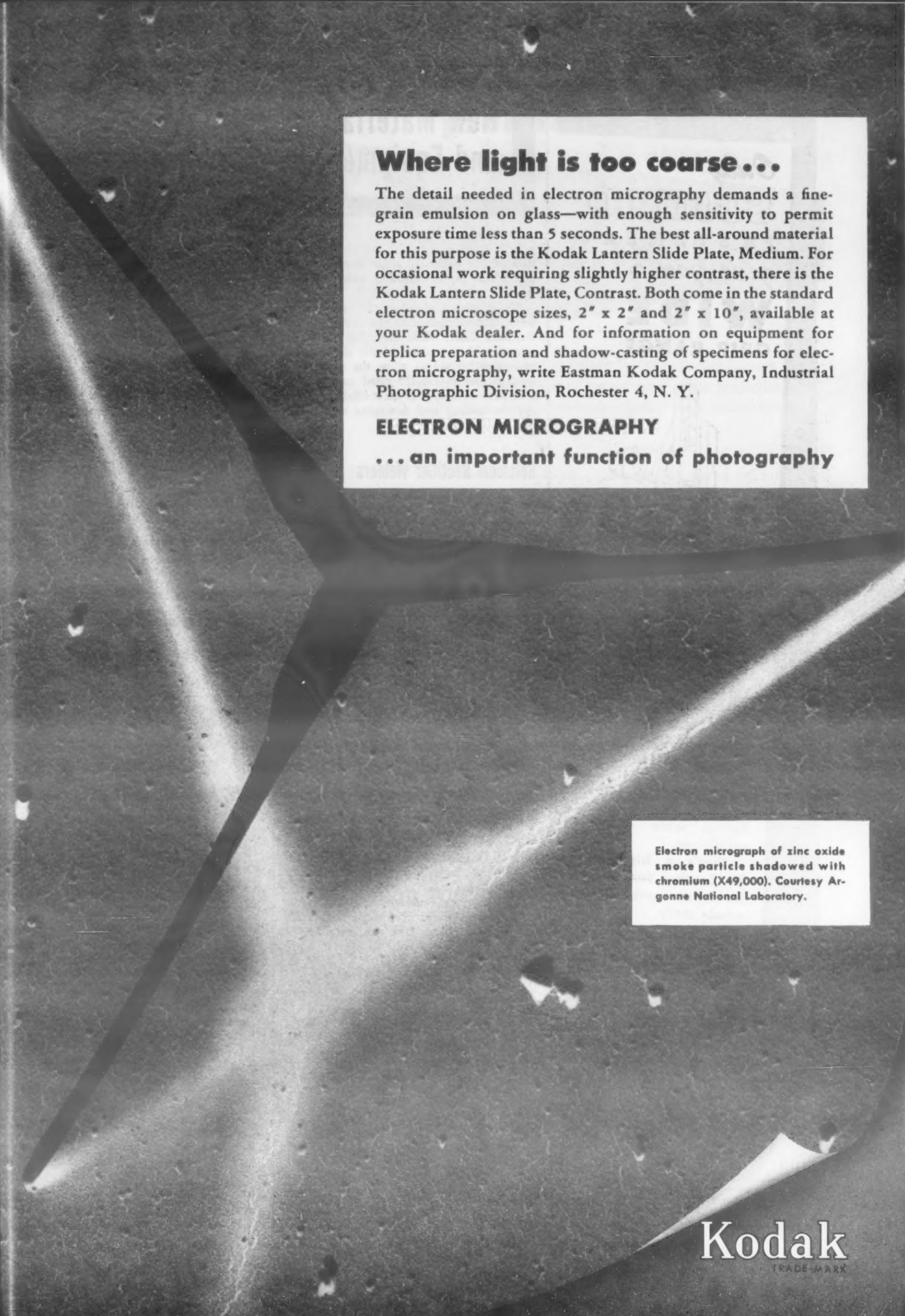
Designed for welding thin-gage materials,

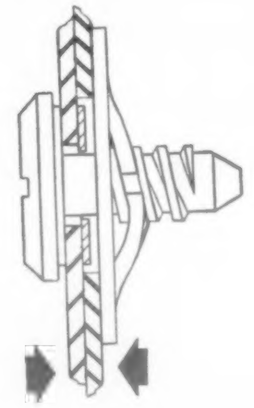


This new torch can be used with either straight-polarity direct current or high-frequency stabilized alternating current.

the AW-9 torch has a torch head and handle assembly weighing only 3 oz, although it is said to have a maximum current capacity for continuous duty of 75 amp.

In operation, the torch head is set at a 120-deg downward angle from the handle. By interchanging the collet nut and torch cap, the angle of the head can be changed


Where light is too coarse...
The detail needed in electron micrography demands a fine-grain emulsion on glass—with enough sensitivity to permit exposure time less than 5 seconds. The best all-around material for this purpose is the Kodak Lantern Slide Plate, Medium. For occasional work requiring slightly higher contrast, there is the Kodak Lantern Slide Plate, Contrast. Both come in the standard electron microscope sizes, 2" x 2" and 2" x 10", available at your Kodak dealer. And for information on equipment for replica preparation and shadow-casting of specimens for electron micrography, write Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.
ELECTRON MICROGRAPHY
...an important function of photography
Electron micrograph of zinc oxide smoke particle shadowed with chromium (X49,000). Courtesy Argonne National Laboratory.
Kodak
TRADE-MARK



New Materials and Equipment

to a 60-deg backward angle from the handle, which permits making welds in tight spots.

Nylon plastic sheathes the entire torch body, thus safe-guarding the operator from electrical shock, while the collet nut is insulated with a molded plastic shield. This protection is said to allow the use of the torch at its maximum rated capacity for long periods of time at great efficiency without overheating and damaging equipment.

Selenium Rectifier Welders

New dual 300/600- and 400/800-amp selenium rectifier d.c. welders are available from *Westinghouse Electric Corp.*, P. O. Box 2099, Pittsburgh 30, Pa.

Each dual unit offers two welding circuits in one common enclosure. Both can be used independently, or in parallel, to provide a single circuit of twice the capacity.

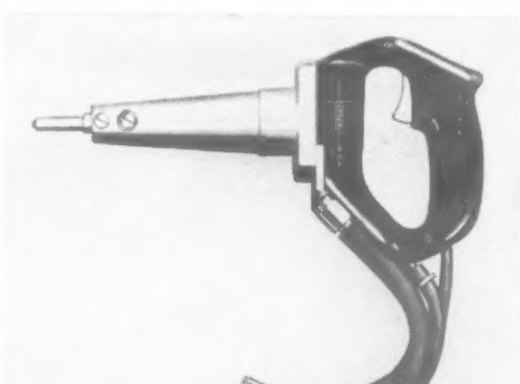
Parallel operation of the two units for maximum capacity is obtained by means of a bridle placed across the secondary output terminals, while a clutch-and-sprocket and chain arrangement is said to make possible independent or unit operation of the current control handles on each individual welder.

To facilitate use of these machines on automatic and stud welding applications, a primary contractor is supplied.

Rivet Gun

A rivet gun using du Pont explosive rivets for high speed operation is currently being manufactured by *Ripley Co., Inc.*, Middletown, Conn.

An important feature of the gun is that it eliminates the need for back-up, hammer and bucking board. The tips are made of



Applications for this new rivet gun are found in the manufacture of airplanes, radios, heating and ventilation ducts, electrical appliances, etc.

New Materials and Equipment

nichrome steel welded to a bronze base, while the handle consists of a two-piece molded phenolic casing in which is housed a handy off-on switch for easy manipulation.

Ideal for maintenance or repairs, the gun is said to be ready for instant action on blind riveting and all conventional fastening jobs at the touch of a switch.

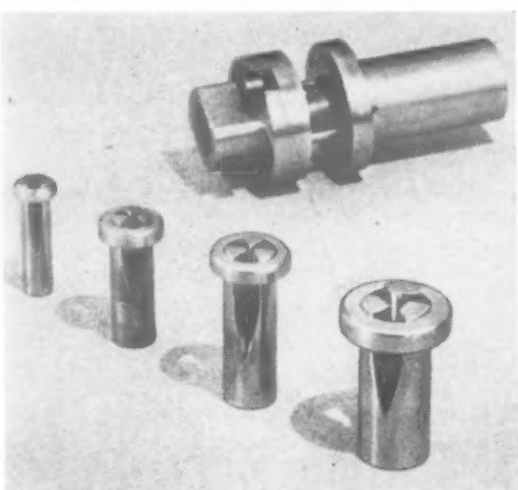
•

Forming & Machining

Small Prong Dies

A new line of small prong dies designed to produce more uniform and smoother precision threads has been announced by *Woodruff & Stokes Co.*, Quincy 69, Mass.

Made for use with Brown & Sharpe automatic and hand screw machines, Swiss-type screw machines, and for hand use, the dies have a pitch of from 36 to 360 threads per in. for diameters from 0.250 to 0.016 in. Tolerances can be held to $\pm$0.0002-in. pitch dia.



These dies are available in either high-speed, carbon or special alloy steel.

All dies are said to be accurately hobbed and lapped for smooth threads and sharp cutting edges, with radial chamfers carefully ground and honed.

Punch Press

Especially designed for die cast trimming and light sheet jobs, the new punch press now being manufactured by *Johnson Machine & Press Corp.*, Elkhart, Ind., is said

New Materials and Equipment

to exert 43 tons of pressure at the bottom of its stroke.

The new press features over-size arms and, according to the manufacturer, a longer stroke, greater bed area, and a larger ram face than most punch presses in its size range.

Available in both flywheel and geared types, the new Model 44 press (geared type) is powered with a 3-hp motor which operates at 1800 rpm. Its gearing ratio is five to one and the back shaft has a speed of 230 strokes per min.

New Type Punch

Designed to cut smooth, accurate holes in various types of sheet metal, the new Zing punch manufactured by *West Pacific Co.*, 1825 S. W. 6th Ave., Portland, Ore., works on a simple punch method enabling the workman to quickly punch out a hole by hand.

Consisting of an anvil, an adapter ring which enables two sizes of holes to be punched on the same tool, a chisel guide, and a special shaped chisel, the punch is said to be an exceedingly fast hand method of cutting holes in sheet metal, able to cut a 4-in. hole in stainless steel in less than 60 sec.

The punch is practically indestructible, according to the manufacturer, and requires no outside source of power.

•

Testing & Control

Hardness Tester

A newly designed automatic certifying hardness tester for sheet metal parts, said to save about 70% of inspection time, has been announced by *Topflight Tool Co., Inc.*, 116 E. Market St., York, Pa.

Including an adaptation of a Barcol unit, the testing assembly can be set for the desired hardness, and can be certified by means of a conversion chart, Brinell, Rockwell or Vickers numbers. In operation, an impressor needle moves up and down on an anvil. Pieces to be inspected are fed between needle and anvil. When the point contacts a part, a dial reading is visible, and a green light flashes if the piece is of the required hardness. A stamp then automatically certifies the piece while, at the same time, a

New Materials and Equipment

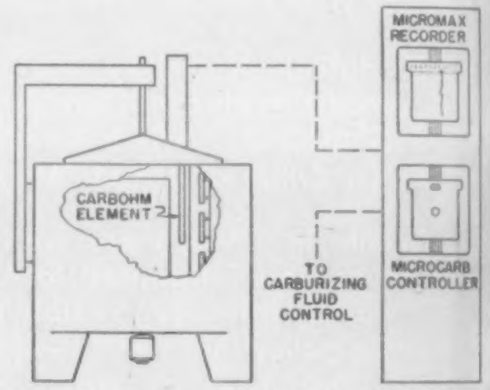
counting device registers the total pieces inspected.

The device will not function if the metal part is not of the required hardness.

Carbon Content Control

A carbon control system which measures and controls the carbon potential of furnace atmosphere directly in terms of per cent carbon has been developed by *Leeds & Northrup Co.*, 4934 Stenton Ave., Philadelphia 44.

Use of this Microcarb control is said to enable heat-treaters to regulate the surface



This Microcarb control measures and controls the carbon potential of furnace atmosphere directly in terms of per cent carbon.

carbon content of steel during heat treatment as accurately as they regulate temperature. The furnace atmosphere can be adjusted to increase or decrease carbon potential automatically for surface carburizing, homogeneous carburizing, carbon restoration hardening, and annealing.

One of the principal features of the carbon control system is a Carbohm detecting element, which projects into the furnace work chamber like a thermocouple and electrically determines the carburizing potential of the furnace atmosphere. Connected to this element is a Microcarb controller which, according to the manufacturer, automatically adjusts the flow of carburizing fluid to hold carbon potential of the furnace gas at any selected value between 0.15 and 1.15% carbon.

For the heat treater's guidance, a Micromax recorder draws a continuous record of percentage of carbon detected by the Carbohm element.

Side Register Control

A new electronic side register control that automatically and accurately maintains the lateral position of a moving web of material on slitting, re-winding and other

Universal Clear Lacquer Simplifies Job Scheduling

The feasibility of using the same lacquer for applying clear protective coatings on a wide variety of metals has made possible not only the reduction of lacquer inventories, but also the more efficient scheduling of finishing jobs. This feature of DULAC Clear Universal Lacquer #462 is particularly important to job finishing shops, and is also a point of considerable value in the finishing rooms of fabricating plants handling more than one metal.

Parts of different metals can be sprayed at the same time by using DULAC #462.

Saves Time in Coating

When DULAC #462 is used, there is no need of switching from one lacquer to another whenever a batch of a new metal is to be finished. Hence the preparation time in the finishing room can be substantially reduced, with more man-hours made available for actual production. Jobs involving different metals can be scheduled to follow one another without delay; in the case of very short runs, many different metals can even be finished at the same time.

Reduces Chance of Error

A further advantage of using DULAC #462 is that it materially cuts down the danger of applying the wrong clear lacquer on a given metal, and thus reduces the risk of inspection rejects or service failures. Technical Data Bulletin #110 on DULAC #462 is available from the manufacturer, Maas & Waldstein Company, Newark 4, N. J.; Chicago 12; Los Angeles 34.

(ADV.)

New Materials and Equipment

processing machines has been announced by the Control Div., *General Electric Co.*, Schenectady 5, N. Y.

Designed to increase production by stepping up machine speeds, the new side register control responds to a signal from a printed line on paper, plastic or cloth 1/32-in. min width. The control ignores all signals from printing adjacent to the guide line on the trailing edge of the scanning

Responding to a signal from a printed line on paper, plastic or cloth of 1/32-in. min width, this electronic side register control increases machine speeds.

sweep, according to the manufacturer, and follows broken lines of the same width. It will not change web position if the web breaks. Instantaneous response is said to be provided for errors as small as 0.001 in. or less.

General

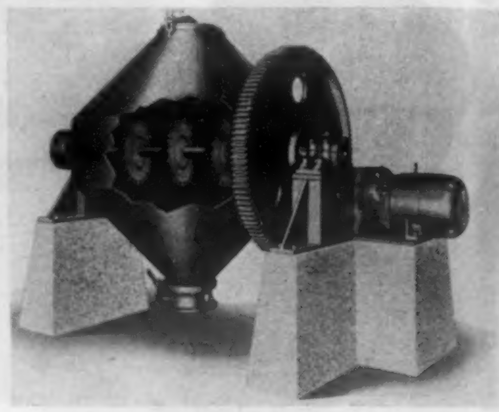
Conical Blender

The Patterson Foundry & Machine Co., East Liverpool, Ohio, is now manufacturing a new disintegrating conical blender which is said to mix chemicals, pigments, powdered metals and resins that contain small amounts of moisture, even if these materials form agglomerates during the mixing cycle.

Disintegrating elements mounted on a shaft extending through the blender trun-

New Materials and Equipment

nion rotate at high speed in counter rotation, breaking up any agglomerates that are formed without reducing particle size.



Designed to break up agglomerates during mixing, this new blender is produced in sizes having capacities of 0.35 to 550 cu ft.

This new blender is produced in sizes having operating capacities of 0.35 to 550 cu ft, and is available in mild steel or alloys, as required.

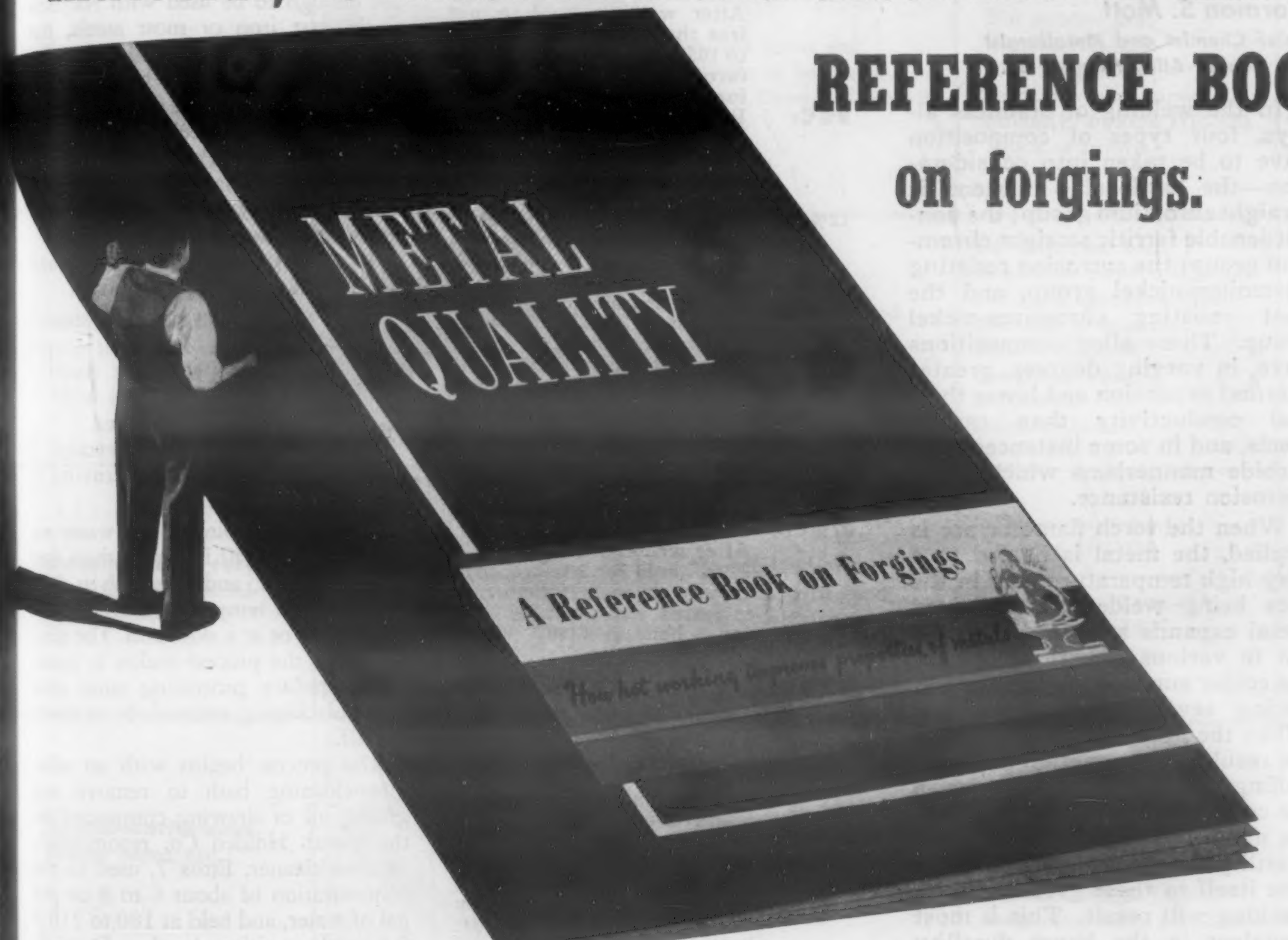
Vitrified Bond

Boosts in grinding and finishing output are said to be indicated by the development of a new vitrified bond for grinding wheels by *Chicago Wheel & Mfg. Co.*, 1101 W. Monroe St., Chicago 7.

Called "79E", the bond is recommended by the manufacturer for portable grinding of billets, brake drums, forgings and forging dies, annealed malleable castings, steel castings, and stainless steel welds. The bond is said to assure a smoother, faster cutting action for vitrified grinding wheels operated at speeds up to 6000 surface ft per min. It provides longer production time per wheel and less down-time for change-over or wheel dressing.

A new vitrified bond assures a smoother, faster cutting action for this grinding wheel.

What *Forgings* have that offer so many more economic, engineering and production advantages than can be obtained with any other material, is illustrated and described in this REFERENCE BOOK on forgings.



Write for a copy. Then consult a forging engineer about how you can obtain the correct combination of mechanical qualities in forgings for your particular type of equipment.

DROP FORGING ASSOCIATION
605 HANNA BUILDING • CLEVELAND 15, OHIO

DROP FORGING ASSOCIATION • 605 Hanna Building • Cleveland 15, Ohio

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metals", 1949 edition.

Name...Position....................

Company...

Address..

A REGULAR SERVICE OF THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.

Technical Topics

WELDING STAINLESS ALLOYS

Norman S. Mott
Chief Chemist and Metallurgist
The Cooper Alloy Foundry Co.

In the welding of stainless alloys, four types of composition have to be taken into consideration—the hardenable martensitic straight chromium group; the nonhardenable ferritic straight chromium group; the corrosion resisting chromium-nickel group, and the heat resisting chromium-nickel group. These alloy compositions have, in varying degrees, greater thermal expansion and lower thermal conductivity than carbon steels, and in some instances have carbide mannerisms which affect corrosion resistance.

When the torch flame or arc is applied, the metal is heated to a very high temperature only in the area being welded. The heated metal expands and tends to push out in various directions against the colder surrounding metal, producing severe internal stresses. When the heat source is removed, the resultant contraction produces pulling stresses acting between the cooling and the cold metal. If the metal does not have sufficient ductility to stretch and accommodate itself to these great stresses, cracking will result. This is most prevalent in the lower ductility straight chromium grades. By making temperature gradients as gradual as possible, this danger can be minimized.

In the chromium-nickel corrosion resisting alloy types, a form of grain boundary carbide precipitation occurs during welding. To offset the dangers of intergranular corrosion, these carbides must be put into solution by subsequent heat treatment before the welded metal is put into use.

Difficulties which are involved in welding cast stainless steel can be overcome through the use of pre-welding and post-welding thermal treatments as indicated below. Alloys for heat resistance applications usually do not require any thermal treatment after welding.

Alloy	*Remarks*
5% Cr	Preheat to 400° F. or over. After welding, cool to not less than 300° F. then heat to 1650° F. . . . hold for 1 hour, furnace cool to 1350° F., hold for 2 hours, then air cool.
9% Cr	Preheat to 400° F. or over. After welding, cool to not less than 300° F. then heat to 1350° F. . . . hold for 2 hours, then air cool.
12% Cr	Preheat to 400° F. or over. After welding, cool to not less than 300° F. then heat to 1350° F. . . . hold for 4 hours, then air cool.
16% Cr	Preheat to 250-300° F. After welding, cool to 250° F. or lower, then heat to 1450° F. . . . hold for 4 hours, then air cool.
18% Cr	Preheat to 250-300° F. After welding, cool to 150° F. or lower, then heat to 1450° F. . . . hold for 4 hours, then air cool.
27% Cr	Preheat to 250° F. or over. After welding, heat to 1650° F. . . . hold for 2 hours, then rapidly air cool. If distortion is feared stress-relieve weld for 1 hour at 1350° F. followed by air cooling.
18-8S	Preheat not required. After welding heat at 2000° F. for 1 hour, then water quench.
18-8SCb	Preheat not required, nor is post heat. However, after welding, it may be stress-relieved at 1650° F. for 2 hours followed by air cooling.
18-8SMo	Preheat not required. After welding heat at 2000° F. for 1 hour, then water quench. Sufficiently ferritic alloys can often be used without post heating.
FA-20	Preheat to 400° F. After welding cool very slowly then heat to 2000° F. . . . hold for 1 hour and water quench.

New Blackening Bath for Ferrous Metals

by A. F. HOLDEN, President, A. F. Holden Co.

● A NEW BLACKENING BATH, versatile enough to be used with stainless steels, cast iron or most steels, has been announced by A. F. Holden Co. It will produce a dense black surface on cast iron, malleable cast iron, mild steel and stainless steel. Offered under the trade name Perma-Black, it is finding use in blackening of ferrous metals for either increased corrosion resistance or nonreflectivity.

The following advantages are claimed for the new preparation:

1. It is used as a clear water solution.
2. The bath operates at moderate temperature, and without objectionable fumes.
3. Processing time is shortened.
4. Installation and operating costs are low.

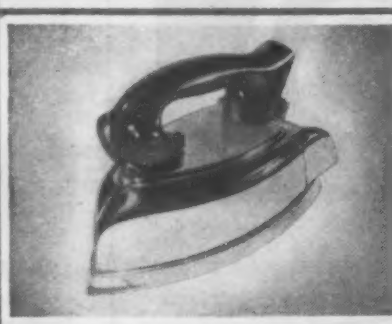
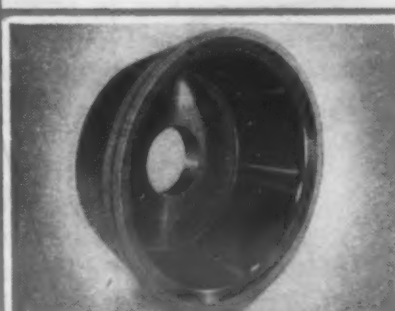
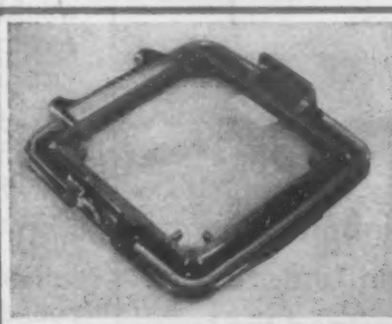
The boiling point of the water solution is about 40 F higher than that of pure water, and the bath is best operated at a temperature slightly below 250 F, or at a slow boil. The simplicity of the process makes it possible to reduce processing time over other blackening methods by as much as half.

The process begins with an alkaline cleaning bath to remove any grease, oil or drawing compound on the metal. Holden Co. recommends its own cleaner, Estox 7, used in the concentration of about 6 to 8 oz per gal of water, and held at 180 to 210 F for quick, positive cleaning. Depending upon the amount of grease or other contaminant to be removed, the metal can be held in the alkaline cleaner for anything from a brief dip to about 3 min. Adding a small amount of sodium cyanide, about 1 oz per gal, will improve the cleaning action of the bath with certain steels. A cold water rinse follows the alkaline treatment.

The rinsed parts are then given an acid treatment to prepare the metal surfaces for the blackening bath. This preparation is supplied by Holden Pre-Clean, and the work should be held in the bath for from ½ to 1 min. The bath is made up with one part of chemical to three of water,

(Continued on page 130)

HOW TO CHOOSE YOUR HEAT RESISTANT GRADE PHENOLIC MOLDING COMPOUND

What do you make?		Properties you need	DURITE recommends
Heater plugs and similar appliance parts.		Excellent finish and resistance to heat and moisture, improved impact strength.	For general use: DURITE HR-320 For highest heat resistance and impact strength: DURITE HR-330 Black or brown.
Cooking utensil handles, electric iron handles, etc.		Lustrous finish, good heat and moisture resistance.	For improved heat resistance: DURITE HR-300 For good heat resistance with higher impact: DURITE HR-310 For general use: DURITE GP-110 Black or brown.
Diamond wheel cores and similar industrial applications.		Improved impact coupled with good heat resistance.	Improved impact: DURITE HR-330 Black. Highest heat resistance: DURITE HR-340 Black or brown.
Electric waffle base, toaster bases, etc.		Lustrous finish, good heat and moisture resistance.	For general use: DURITE GP-110 For improved heat resistance: DURITE HR-330 For improved heat resistance with higher impact: DURITE HR-340 Black or brown.
Heavy duty switches.		Good heat and moisture resistance with good impact properties.	For general use: DURITE HR-340 Black or brown. For improved impact: DURITE HR-330 Black.

FREE: Write for catalog, fully describing the wide range of DURITE phenolics for General Purpose, Heat Resistance, Electrical Resistance, Impact Resistance —and made-to-order modifications of standard materials embodying special characteristics to meet your specific requirements. Address:

THE BORDEN COMPANY · CHEMICAL DIVISION
Dept. MM-11, 350 Madison Avenue
New York 17, N. Y.

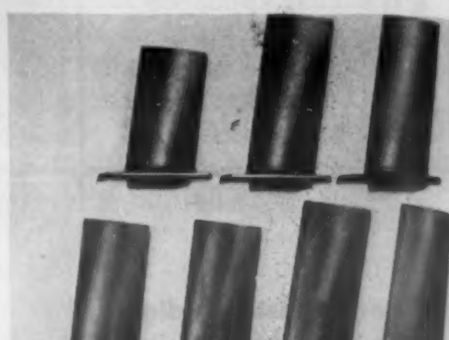
DURITE

Molding Powders · Bonding Resins · Cements

continued from page 128

and is operated at 160 to 190 F. A thorough rinsing in cold running water follows the pretreatment.

The blackening bath, made up with 3 to 3½ lb of blacking salt per gal of water, is held at about 240 to 250 F, preferably nearer the former temperature. The work goes directly from the rinse into the blackening bath, where it is held for 3 to 5 min, the exact time to be determined by trial with a few sample pieces. If the temperature tends to climb above the 250 F recommended as a maximum, a little cold water can be dripped into the bath. A deep black color develops



Turbine blades after receiving new blackening treatment.

quickly, and after the time fixed upon as giving best results has elapsed, the work is removed from the bath and given a final cold water rinse.

Additional corrosion protection can be given the work by a final oiling. The oil treatment also imparts depth of color to the finish. A dip into a soluble oil at about 200 to 220 F will accomplish this purpose. Where service is unusually severe, the final oiling is recommended for maximum resistance to rusting.

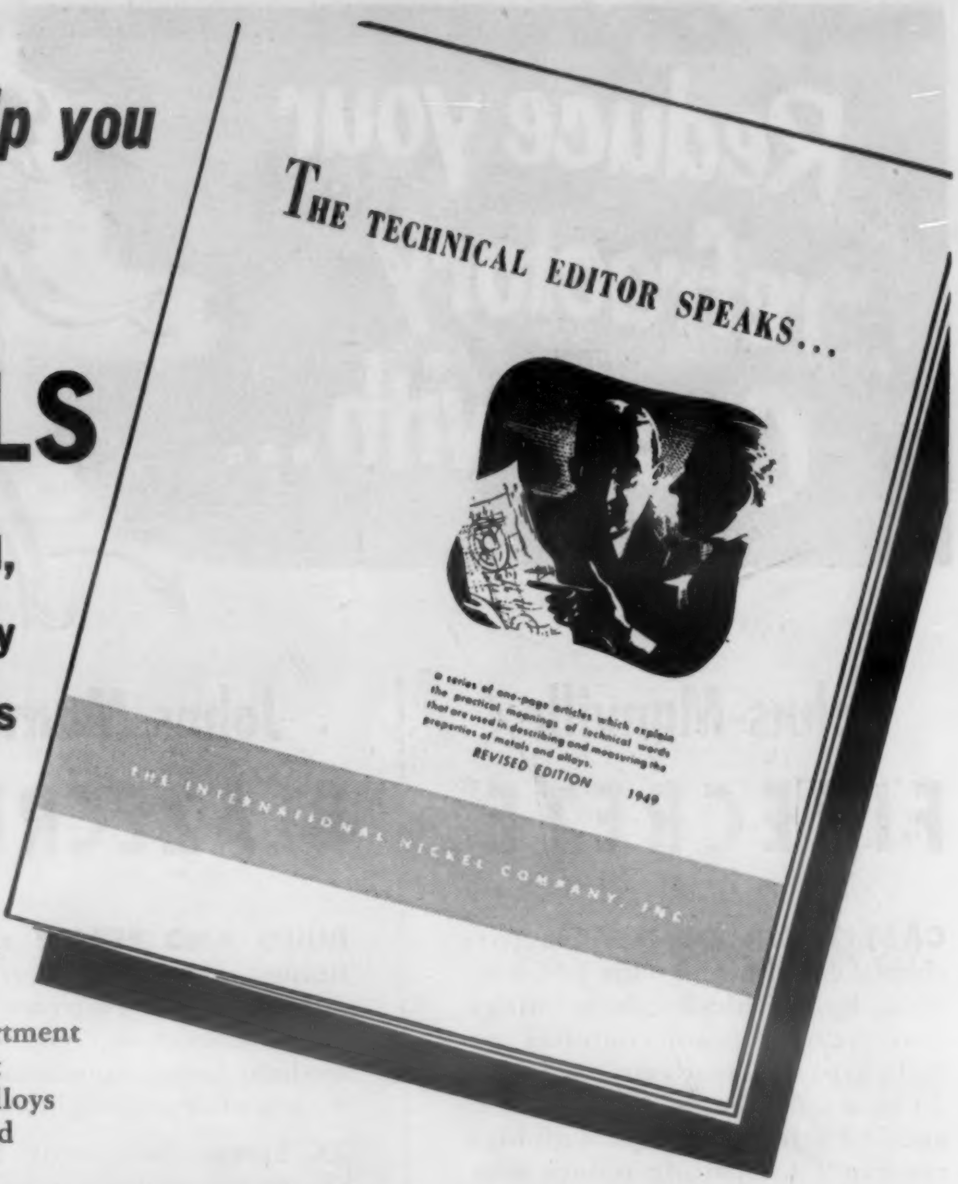
The blackening bath chemicals are not unduly corrosive, and Perma-Black can be made up in any tank suitable for other blackening compounds.

Although the process is still quite new, it has been used experimentally for a wide variety of small parts, usually to confer additional corrosion resistance upon the pieces being blackened. It is also being used for the blackening of metal television tubes, where a nonreflective surface is a requirement. Typical of the treatment of metal for corrosion resistance is the blackening of piston rings, where service life has been greatly extended under severe conditions. Salt spray tests begun by a large New England company using the process for an ordnance item have not been completed, but preliminary results show that service life of the item is greatly lengthened by blackening.

This free booklet will help you

GET MORE OUT OF METALS

...and also understand why Monel, Nickel and Inconel are critically needed for the "really tough" jobs



Here's a booklet that's a "must" for any one who chooses or uses metals.

And, with all metals in ever-shortening supply, it's a *timely* booklet that can help you make the best use of the metals you're getting.

Written by the Development and Research Department of The International Nickel Company, this booklet explains the mechanical properties of metals and alloys so that the reader is able to understand, compare and judge their values for practical applications.

It explains in one-page treatments many of the technical terms and testing procedures needed for a working knowledge of metal behavior.

Also included are many tables of data for comparing the suitability of Inco Nickel Alloys for applications requiring a corrosion-resisting material with high mechanical properties.

Any one who absorbs the information in this booklet will be equipped to do a better job of metal selection. If you're an established engineer, send for this booklet and consider it a quickie refresher course. If you're a newcomer to metals, use this booklet as the shortest cut to acquiring a practical knowledge of metals.

30,000 technical men—from shop hands to college professors—asked for the original edition.

Now this new and enlarged edition is ready. Send for as many copies as needed for yourself and your staff. Just fill in the number on the coupon.

Remember, too, that whenever you have a metal question, you can count on Inco's Technical Service Department to help you solve metal problems involving corrosion, stress, wear, fatigue, high temperatures, low temperatures and shock.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS
TRADE MARK

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"®

36 PAGES OF INFORMATION ABOUT METALS

Tensile Properties
Yield Strength, Proportional Limit, Proof Stress, Rigidity, Modulus of Elasticity, Ductility.

Torsional Properties
Twist Resistance.

Hardness
Brinell, Rockwell and Vickers Tests. The Scleroscope.

Toughness
Impact Strength, Izod and Charpy Tests. Tension and Torsion Impact.

Shear Strength

High Temperature Properties

Thermal Expansion

Low Temperature Properties

Fatigue
Effect of Keyways on fatigue of shafting.

Corrosion
Concentration-Cell, Galvanic.

Cavitation-Erosion

Physical Constants and Mechanical Properties of Important Metals

Conversion Tables
Measurements.

Definition and Glossary of Terms

Use this coupon

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N.Y.

Please send me..............copies of "The Technical Editor Speaks."

Name________________________

Title________________________

Duties________________________

Company________________________

Address________________________

MM-1-51

A LETTER TO THE EDITOR

To the Editor:

Re: Your article "Chromium Plating Directly on Aluminum by New Process," MATERIALS & METHODS, October, 1950, pp. 56-57

I have recently read the subject article with particular interest since, as you may know, Enthone, Inc., sells a patented process for plating on aluminum by means of a copper-containing zincate immersion dip. This is the Enthone "Alumon" process.

In your discussion of the Cro-plate process for chromium plating directly on aluminum by mechanically freeing the aluminum of its normal oxide film, you have indicated that a coating of the water suspension of abrasive is left on the aluminum surface until the part is placed in the chromium bath. You have further stated that this coating is thick enough so as to "—prevent any action by air on the cleaned aluminum—". It is our belief that such a slurry will contain some air and thus some oxidation of the surface will occur. The amount of oxide, however, may be so small as to have no ill effect on the adhesion of the deposited chromium.

In another section of the article you have indicated that the most commonly used method of plating chromium on aluminum is by using the zincate process followed by copper, nickel, and then chromium. We would like to point out that many users of the Enthone "Alumon" process regularly plate only nickel or nickel and chromium directly on the "Alumon" treated surface and that several users, including government and commercial installations, have been plating chromium directly on the "Alumon" treated surface. Items finished by this means have successfully passed stringent heat and wear resistance tests.

With respect to your statement regarding the costs of plating chromium directly on aluminum, we sincerely doubt that costs could ever be lower than the direct plating of chromium on steel. The writer had previously been engaged in that type of work for several years and knows that the preparation cost for plating on steel involves only low cost alkaline and acid cleaning and, occasionally, a reverse current treatment in the plating bath or a similar solution. It is even doubtful that the Cro-plate process could equal the cost of direct chromium plating on aluminum by means of the "Alumon" process. There is no doubt that the necessary equipment for the "Alumon" process will be less costly.

Your statement, "—plating on steel can be done without intermediate coatings, such as copper—", implies that chromium cannot be electroplated directly on steel. This opinion should be corrected, as practically every chromium plating establishment in the world has successfully done this type of work. Many publications in periodicals and books have discussed the method as early as the late 1920's.

Very truly yours,
Hubert M. Goldman

Enthone, Inc.

News Digest

ASME Papers . . .

continued from page 8

reported that the steel, of approximately WC-4 grade, showed no loss of strength, no embrittlement and no occurrence of graphite.

In "Creep and Creep-Rupture Testing of Steam Boiler Materials", J. B. Romer of Babcock & Wilcox Co., and D. H. Newell, of B & W Tube Co., described the mechanical properties that are considered important in selecting steam boiler materials. The main concern is to select a material which will provide sufficient long-time strength, as well as surface and internal stability of metal, to avoid failure with consequent outage of equipment and economic loss. Since boiler superheaters are generally expected to last more than 100,000 hr, B & W runs both creep and stress-rupture tests for 10% of this service life or longer at temperatures throughout its use range. Creep testing is followed by metallurgical examination of the specimen. This procedure includes hardness and microscopic examination for changes in surface condition and structure of the metal.

A comprehensive summary of the field of application for electric furnace brazing was presented by H. M. Webber, of General Electric Co., in "Furnace Brazing of Machine Parts". He cited examples of furnace-brazed assemblies which had formerly been fabricated by other methods to illustrate the advantages of furnace brazing. Included were discussions of common base metals, brazing alloys, recommended fits, joint design, fixturing practice, brazing furnaces and atmosphere producers.

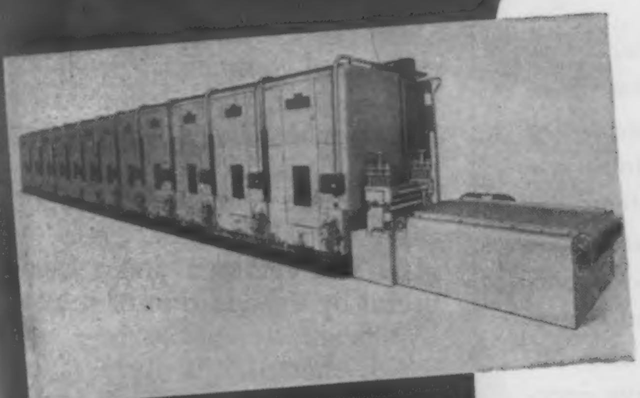
Bearing Design

Embeddability, or the ability of a bearing surface to tolerate abrasives, was one of the factors discussed by A. E. Roach, of General Motors Corp., in his paper, "Performance of Oil-Film Bearings with Abrasive-Containing Lubricants." According to the author, bearings must be designed with enough softness or embeddability to enable them to tolerate the largest size particle to which they may be subjected. Probably the most effective way of doing this would be to provide a facing of soft metal on

At right, MICRO-POLISH unit showing easily accessible controls and neat, compact design.

At left, MICRO-POLISH unit with cabinet removed to show outstanding M-W, three roll belt control system.

MURRAY-WAY MICRO·POLISH



A typical multiple unit installation using twelve standard units in line.

THE BETTER WAY OF SHEET-GRINDING AND POLISHING — PROVED RIGHT IN ACTUAL OPERATION

MICRO-POLISH gives you —

- Higher quality surface for any given grain size.
- A much faster grinding rate without burning.
- Substantial operating economies.
- Unbelievable versatility. MICRO-POLISH handles strip, sheet or blanked parts, any width or length.
- A wet or dry process to meet your needs.
- Dependable, convenient controls, fully shielded from abrasives and foreign matter.

We also manufacture a complete line of automatic buffing and polishing equipment, to handle any contoured or formed parts. Your inquiries are invited.

MURRAY WAY

THE MURRAY-WAY CORPORATION
3925 WEST FORT STREET • DETROIT 16, MICHIGAN
AUTOMATIC POLISHING, BUFFING, GRINDING EQUIPMENT

News Digest

the bearing surface; however, the fatigue strength of such a facing decreases with increasing thickness so that it must be kept as thin as possible. Experiments indicate that for dirt absorption there is little benefit in making the facing much thicker than the maximum size of abrasive particle minus the oil-film thickness.

In "Studies of Relaxation Characteristics of Nonmetallic Gasket Materials", R. G. Farnam, of F. D. Farnam Co., described a relatively simple apparatus designed to measure the relaxation characteristics of gasket materials under simulated service conditions. Nonmetallic gaskets, when subjected to flange pressure, all have some degree of "let-down" after the original tightening of the flanges. This phenomenon is a common cause of not only gasket leaks but of many gasket failures. The author believes that the new instrument will result in a greater knowledge of the subject of relaxation, and make it possible to evaluate gasket materials for actual service.

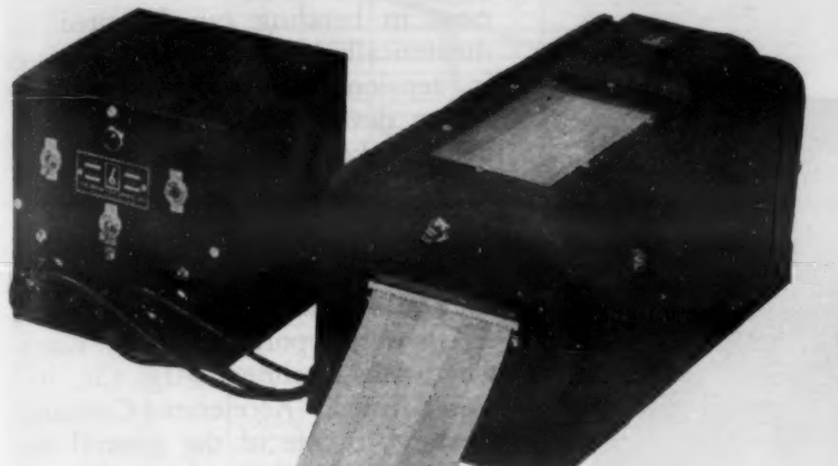
Glass-Coated Steel

"Some Examples of the Functional Use of Glass as a Coating for Steel" were described by W. G. Martin, A. O. Smith Corp. He based his paper on several commercial products, such as glass-lined tanks, domestic water heater tanks and farm crop storage units. In each case, the main advantage of the combination material is that the surface characteristics of the glass are retained and made more useful by the addition of the strength and flexibility of the base metal to which the glass is fused. Both the corrosion resistance and low coefficient of friction of glass are important in some of these applications.

Since information on creep properties is scarce, particularly for stresses other than simple tension, a paper on "Creep Properties of Lucite and Plexiglas for Tension, Compression, Bending and Torsion" is of some interest. As a result of creep tests on these two methyl methacrylates, Joseph Marin, Yoh-Han Pao and George Cuff, of Pennsylvania State College, came to two principal conclusions:

1. Compression creep-time relations for plastics cannot be assumed to be the same as for tension.
2. Creep deflections and creep

Simplify analysis WITH THESE *Brush* INSTRUMENTS



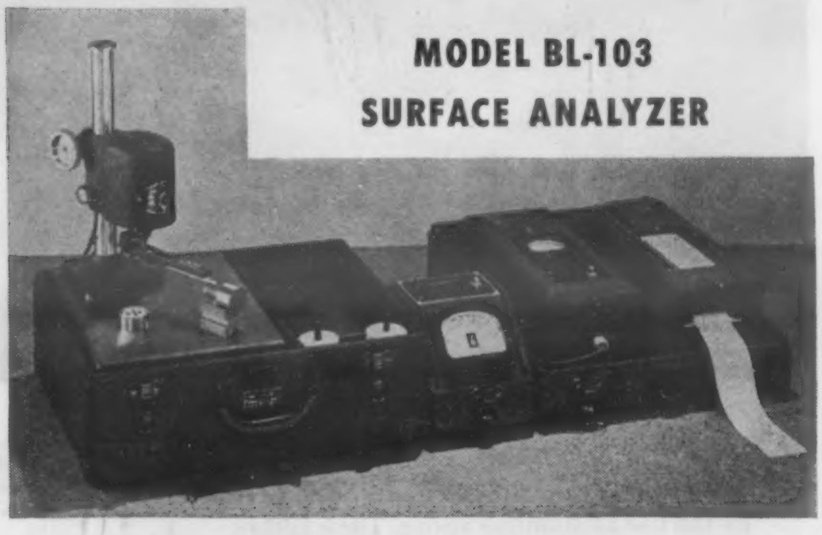
COMBINATION MAGNETIC OSCILLOGRAPH

The Model BL-221 Single Channel Magnetic Combination Oscillograph is similar to the Model BL-201 unit, except that circuit changes have been made to permit use of either a standard inking pen or an electric stylus. Magnetic penmotor Model BL-943 is used on the BL-221 Oscillograph and includes the proper connections for use of the electric stylus. A Power Supply, Model BL-944, furnishes voltage for the electric stylus operation. A switch on the front panel of the Power Supply permits the operator to increase the stylus voltage when recording high frequency phenomena. The main switch opens circuit to Power Supply to eliminate the possibility of receiving electric shock when handling stylus. Instruments are supplied with a standard pen and inkwell as well as the electric stylus. The Model BL-222 Double Channel Oscillograph (shown in illustration) is supplied on the same chassis as the BL-221.

BL-932 D-C AMPLIFIER

Designed for use with the Brush Magnetic Direct Inking Oscillograph, and used to make recordings of many types of phenomena heretofore measured only with the aid of complicated intermediate equipment. Studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures, d-c and a-c voltages or currents, and many others, are simplified by the use of the Brush Direct Inking Oscillograph with the BL-932 Amplifier. Voltage gain is sufficient to give one chart mm deflection per millivolt input. Novel design features reduce the effects of power line fluctuation. Zero signal drift amounts to not more than one chart mm per hour. Frequency response is essentially uniform from d-c to 100 cycles per second. The control panel at the front of the amplifier contains a factor-of-10 attenuator, gain control, calibrating meter, and controls for determining input voltages. A balancing potentiometer is provided for electrically biasing the oscillograph pen to any position on the chart.

MODEL BL-103 SURFACE ANALYZER



For exploration and instantaneous charting of surface finishes—metals, glass, plastics, paper, plated and painted surfaces from less than 1 to 5000 microinches. Complete with PA-2 Pickup Arm, Drive Head, Amplifier, Magnetic Oscillograph, Surface Plate, Carrying Cases, Glass Calibration Standard, 2 V-Blocks, 6 rolls Chart Paper, one 2 oz. bottle Red Ink, connecting cords and operating instructions. Brush RMS METER: "average reading" type calibrated in terms of the "RMS" of an equivalent sine wave. It provides a constant visual check of "RMS" surface roughness in cases where "hill and dale" chart profiles are not needed. Large illuminated dial is set at an easy reading angle. "RMS" Meter may be purchased separately or with the Surface Analyzer.

UNIVERSAL STRAIN ANALYZER

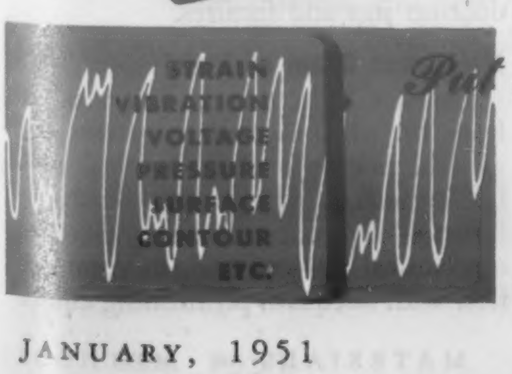
The BL-320 Universal Strain Analyzer, when used with the Brush Magnetic Direct Inking Oscillograph, provides a complete package unit for the measurement of strain or other phenomenon where a resistance sensitive pickup is employed. It can be simply operated, producing records which are immediately available and easily interpreted. This combination equipment records either static or dynamic strains up to 100 cps, and direction as well as magnitude of the measured strain can be read from the chart. Connections are brought out so that one to four active gages may be used. Provision is made for connecting an internal calibrating resistor in the bridge circuit and adjusting the overall gain.

Write for complete details.

THE *Brush* DEVELOPMENT COMPANY

DEPT. G-1, 3405 PERKINS AVENUE • CLEVELAND 14, OHIO, U.S.A.

Canadian Representatives:
A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario



Put it in writing with a

BRUSH RECORDING ANALYZER

STRAIN ANALYZERS • SURFACE ANALYZERS • CONTOUR ANALYZERS • UNIVERSAL ANALYZERS • UNIFORMITY ANALYZERS

News Digest

rates in bending can be predicted theoretically based on creep constants in tension and compression. The theory developed is sufficiently simple to make it applicable in engineering design.

Accelerated-Cavitation Tests

Results of accelerated-cavitation tests on a number of engineering materials were reported by W. J. Rheingans, Allis-Chalmers Mfg. Co., in a paper titled "Accelerated-Cavitation Research". One of the general conclusions reached by the author was that new materials such as the Ampco Bronzes, Colmonoy, Thiokol rubber, etc., might be suitable for hydraulic machinery where cavitation occurs, and might have a distinct advantage over materials now in use. He found that the practical application of the materials, such as the number of passes to be used when making repairs by welding or when prewelding, does influence the resistance to pitting whereas preheating the base metal has little effect. Hardness seems to be definitely related to resistance to pitting regardless of the material used.

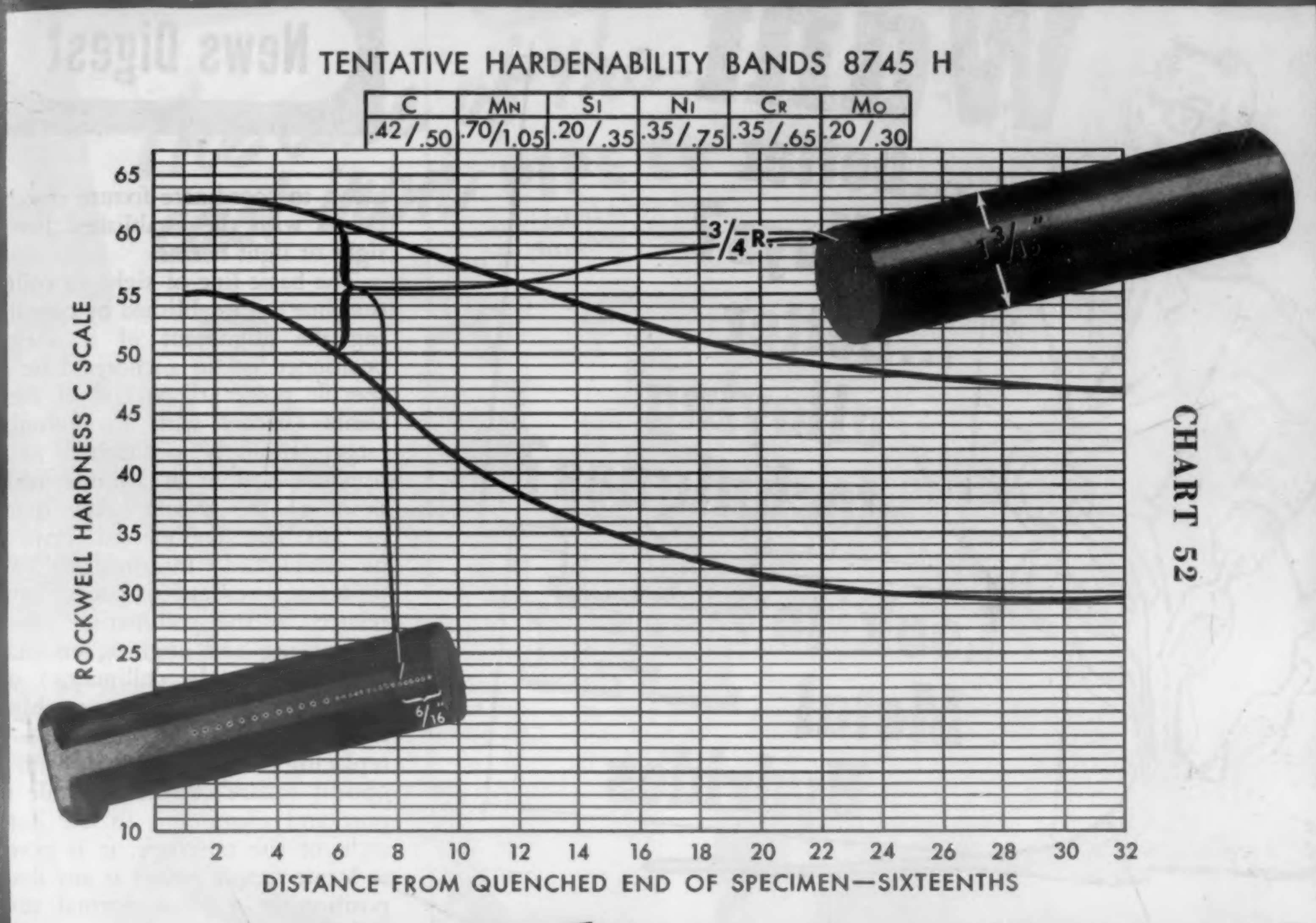
New Optical System Revealed for High Accuracy Jigs, Fixtures

A new system of building production fixtures and jigs, involving the use of a unique optical device and standard castings, has been developed by Republic Aviation Corp. under contract to the Air Force Air Materiel Command. Although developed primarily for use in plane manufacture, the system should have many other fields of application, including the automotive, machine tool and shipbuilding industries.

Utilizing British optical instruments and German castings, this system is said to provide a simplified and less costly means of building production jigs and fixtures.

Reference Beam of Light

Because light travels in a straight line, for all practical purposes, the general principle of the optical tooling system is to establish beams of light as reference lines in place of mechanical devices and, in combination with adequate positioning equip-



You Gain When You Order Alloy Steels To Hardenability

While many users buy alloy steels to chemical analysis, there is often a considerable saving involved when grades are ordered to hardenability instead.

When you order "H" steels specified by hardenability bands you eliminate top and bottom analysis extremes, thereby promoting uniformity. This provides definite advantages, as top extremes in hardenability frequently cause quenching cracks, and bottom levels may mean failure to obtain the needed effectiveness of quench.

For example, suppose you need a 1³⁄₁₆-in. round that will quench in oil to Rockwell C-50 minimum hardness at the three-quarter radius. (At this point, the hardness value is approximately equal to that of martensite.) Standard cooling rate curves for a mildly agitated oil-quench show the commensurate distance from the hardened end of the end-quench test to be ⁵⁄₁₆ in.

When this required distance is located on an established hardenability chart, such as the one reproduced above, we find that 8745 H analysis will produce 50 minimum and 61 maximum hardness. This indicates that 8745 H meets the requirements. The possibility of getting an 8745 type steel of greater or lesser hardenability is eliminated when the "H" steel is ordered.

Our metallurgists will gladly explain in detail the advantages and savings in ordering steels to hardenability. They will also help you with heat-treatment and machining problems.

We manufacture the entire range of AISI grades and special-analysis steels as well as carbon steels.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation.

BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL

News Digest

ment, to coordinate fixture matching points with the established lines of sight or light beams.

The basic line of sight (a collimation line) is established by coordinating the alignment of a telescope positioned on an anchored base at a specific point at one end of the assembly fixture with an illuminated target similarly positioned at the opposite end or at an intermediate point of the fixture. Any number of auxiliary collimation lines can be established. Intermediate fixture points at any desired spacing can be related to the collimation line by interposing and aligning an illuminated target (the collimator) on a movable support in the established line of sight of the telescope. By replacing the collimator with an optical square on the movable support and aligning it in the line of sight of the telescope, it is possible to locate fixture points at any desired position in a plane normal to the collimation line.

Method Offers Economies

The advantages claimed for this optical tooling method are: (1) Reduced cost of tools and consequent reduction in cost of the end product. (2) Improved accuracy of assembly fixture construction is obtained. In a 50-ft span, for example, a tolerance of 0.0015 in. in vertical and horizontal displacement can be met if necessary. (3) It permits design of large assembly fixtures which can be broken down into small units for transporting or stock piling. (4) The system of erection of assembly fixtures is simplified, permitting rapid training of comparatively inexperienced manpower for manufacture of assembly fixtures in case of emergency. (5) It enables the jig builder to erect fixtures to dimensional accuracy that will provide interchangeability without the use of masters for coordination.

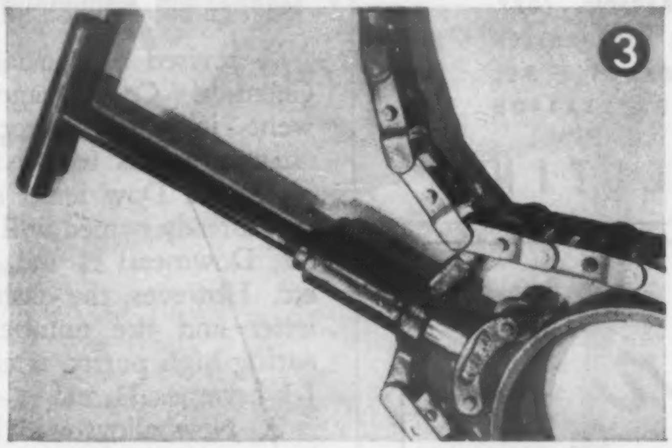
For the basic structure of the fixtures, standard piping and standard castings, which become the structural joints of the framework, are used instead of welded construction. The use of piping assembled with bolted standard castings has a number of advantages, namely (1) fixture parts interchangeability, (2) lower cost, (3) use of unskilled labor, and (4) rapid knock down for shipment, reuse or changes. In this type of

The case of the cast iron PIPE CUTTER

—as related to us by an executive of Springload Mfg. Corp., Seattle, Washington.

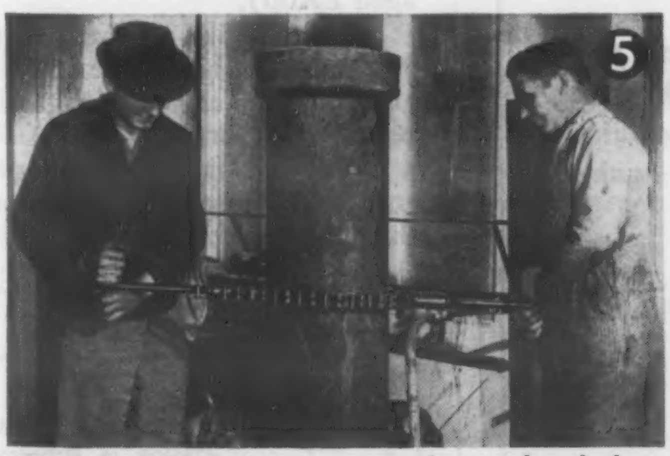
"WHEN WE STARTED making this cutter, one main problem was finding a way to attach a machined bar to a piece of tubing, and adding a T handle to the tubing.

"WHAT MADE THE PROBLEM more tricky, the joints had to take severe stresses—both rotary and tensional. It was without solution until your representative demonstrated EASY-FLO low temperature silver alloy brazing.



"WE'VE BEEN DOING THE JOB with EASY-FLO for over two years now. It gives us the strong joints we need and also meets all our production requirements.

"THESE TOOLS CUT cast iron soil pipe, water pipe and Duriron pipe from 2" to 12" sizes. They're very easy to use, cut clean and true and much faster than other methods.



"ALTHOUGH THERE ARE many thousands of these tools out and they are usually used under rough conditions, we have yet to encounter any difficulty from the EASY-FLO brazed joints."

The Same Service Is Yours—Anytime

■ We maintain a corps of thoroughly trained and experienced specialists just to show manufacturers what our low-temperature silver brazing alloys can do on their work and to help solve specific problems. We'll be glad to send one to your shop—anytime—without cost or obligation. The new BULLETIN 20 gives the full story about the alloys and the valuable services that go with them. Write for a copy today.

HANDY & HARMAN FOUNDED 1867 QUALITY SERVICE

HANDY & HARMAN

82 FULTON STREET • NEW YORK 7, N. Y.

Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada

Agents in Principal Cities

News Digest

construction, castings are used for assembly of all parts, including installation of fixture bracing, fixture fittings and brackets for alignment instruments, thereby completely eliminating welding in the assembly of the fixtures. It is apparent that this type of construction, combined with standardization of the developed types and sizes of castings, will not only effect an appreciable saving in critical materials and assembly labor in fixture construction but will also reduce the elapsed time for initial construction or duplication of fixture assemblies.

Magnesium Nomenclature Changed

A revised nomenclature for Dow Chemical Co.'s magnesium alloys went into effect recently. These changes are as follows:

1. The Dow letter system for alloys already named will be continued, *i.e.,* Dowmetal H will remain as is, etc. However, the dash between the letter and the number "1", designating high purity, is eliminated and J-1 becomes J1, etc.

2. New alloys will be designated by the new ASTM system. For example, ZK60 becomes ZK60A (formerly this was the designation for aged ZK60).

3. The ASTM temper system will be used to designate the condition of all alloys. Temper designation is separated from alloy designation by a dash. The table below shows old and new temper designations and their meanings:

Old	New	Meaning
AC & r	-F	As cast, as rolled or as extruded. Used when alloy is supplied in conditions other than as fabricated, *e.g.,* 01-F and ZK60A-F
S	-T2	Stabilized or annealed (cast products)
HT	-T4	Solution heat treated
A	-T5	Aged
HTA	-T6	Solution heat treated and artificially aged
a	-0	Annealed (wrought products)
h	-H24	Hard rolled (sheet)

News Digest

AWS Papers . . .

continued from page 11

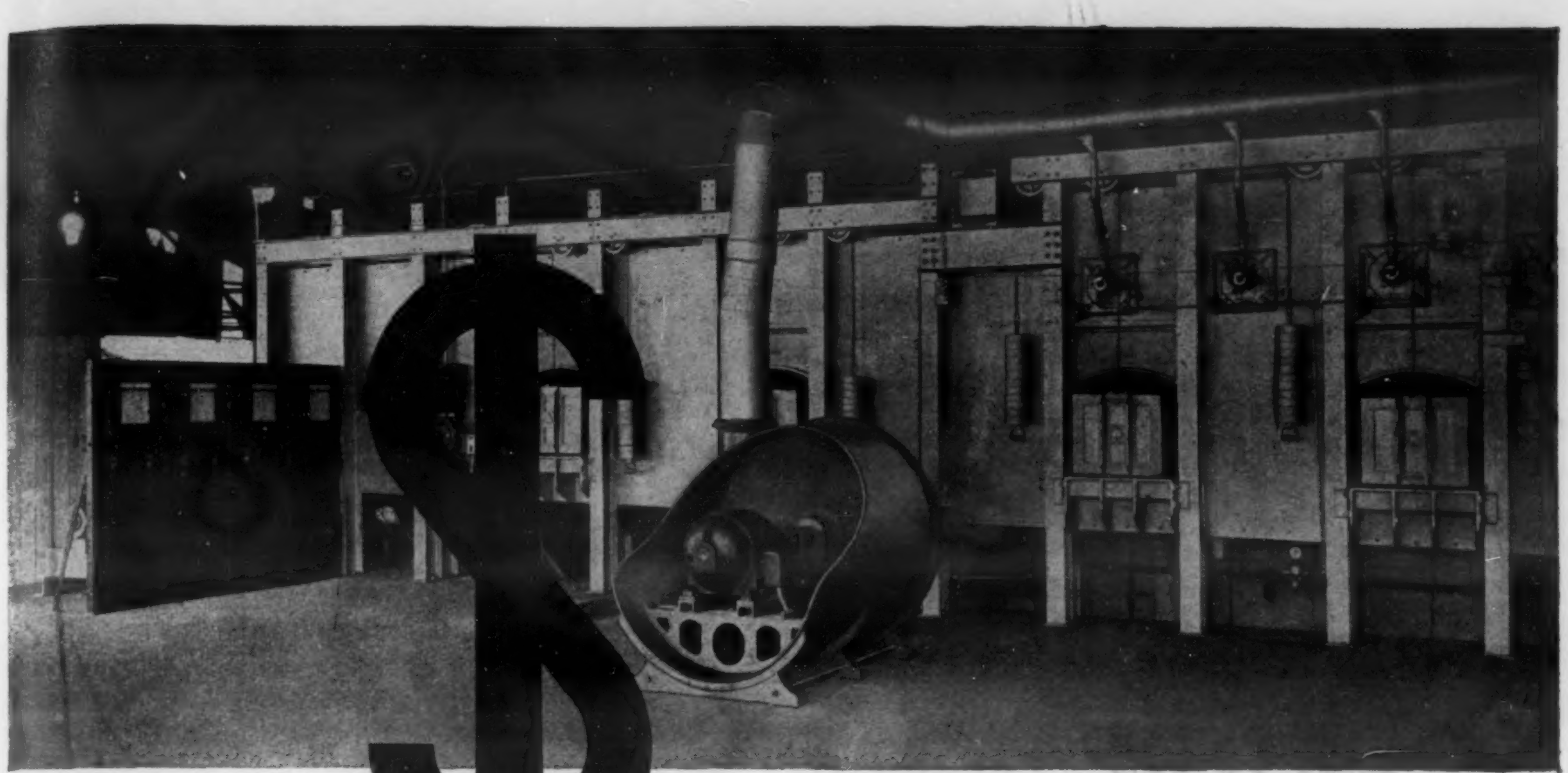
Copper Brazing Alloys

Copper alloy brazing and braze welding finds considerable use for production joining of a variety of parts, and three copper alloys are used for most of the applications. In their paper, "Copper Alloy Brazing for Production Economy", C. E. Swift and E. B. Brown describe the properties and uses of these three copper alloy welding rods. These alloys are: (1) a low fuming bronze—approximately 59 copper, 39% zinc and the balance small amounts of tin, iron, manganese and silicon; (2) a nickel silver low fuming welding rod composed of about 46 copper, 44 zinc, 10% nickel and the required deoxidizers; (3) a copper silicon alloy composed of approximately 96 copper, 3 silicon and 1% manganese.

The low fuming bronze and the nickel silver alloys are used with the oxyacetylene torch, or applied as preplaced rings and the assemblies heated in a furnace by special gas burners or by electrical high frequency induction equipment. All of these alloys develop the strength of the low carbon steel in fillet welds and vee-butt joints. The low fuming bronze and the nickel silver alloys develop much higher shear strengths when they flow into lapped joints by capillary action. The use of these copper alloys for joining light gage structural steel tubing and formed sheet steel shows economies over metallic-arc or resistance welding. These economies are realized through the small investment in equipment required to do braze welding, in the simple preparation required, in the ease of reaching all parts of an assembly, and in the little or no cleaning or finishing required after braze welding.

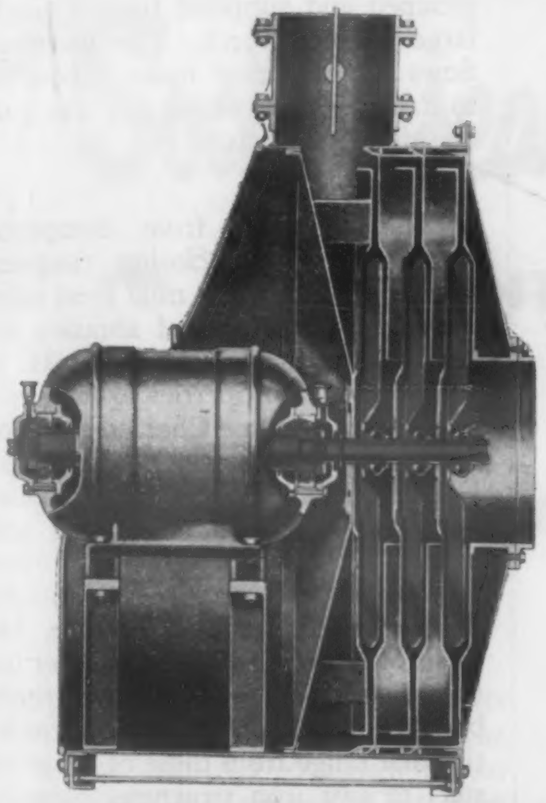
Flame Hardening

A paper, "Commercial Flame Hardening", by E. J. Cox, was directed toward acquainting engineers and manufacturers with the advantages as well as the limitations of flame hardening. The paper outlines the various methods of applying the flame to machine parts, and discusses the various types of quenching media. It also explains other equally important fundamentals, such as control of flame



DOLLAR $ A YEAR MACHINES!

(SPENCER TURBO-COMPRESSORS)



A study of typical plants where Spencer Turbo-Compressors have been in use ten years or more shows less than one dollar per year per machine for spare parts.

The centrifugal design with wide clearances, low peripheral speeds and only two bearings to lubricate is partly responsible for this record.

Original test efficiencies are maintained for the life of the machine. Power is used only in proportion to the load—and efficiencies are high at all loads.

Spencer Turbos have been the preference in heat treating for many years. "Other uses" however have been increasing rapidly. Here are some of the special services that are being rendered by

SPENCER TURBOS

AGITATION
- Electro Plating
- Flotation
- Sewage
- Yeast

GAS BOOSTERS
- Atmos Gas Producer
- Gas Plants
- Premixing Equipment

GAS ENGINE
- Testing
- Super-charging
- Engine Exhaust

VENTILATION AND COOLING
- Scale Blowing
- Glass Cooling
- Mines
- Tunnels

MISCELLANEOUS
- Glass Blowing
- Paint Spraying
- Tin Plate Cleaning

Spencer Turbos are standard in capacities from 35 to 20,000 cu. ft.; 1/3 to 800 H.P.; 8 oz. to 10 lbs. Four bearing, gas tight; single and multi-stage.

ASK FOR THESE BULLETINS

TECHNICAL BULLETIN	No. 126
DATA BOOK	No. 107
GAS BOOSTERS	No. 109
FOUR BEARING	No. 110
BLAST GATES	No. 122
FOUNDRIES	No. 112

359-A

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

SPENCER
HARTFORD

News Digest

characteristics, quench volume, temperature of the materials, and case depth.

Recent developments in flame hardening equipment have resulted in the use of this hardening method on much larger surfaces than heretofore possible. J. J. Barry described such applications in his paper, "Flame Hardening of Large Surfaces". In the progressive spinning method of flame hardening large rounds, the gas flow requirements vary directly with the diameter, and each inch of diameter hardening surface requires a flow of 150 cu ft of acetylene per hr. Two methods of hardening rounds can be used—either multiple tips and torches or manifolded tips which are grouped and supplied from a single large capacity torch. The increased flows available now make it possible to flame harden almost any size part of suitable analysis.

Hard Facing

Weld deposits from composite rods, made by enclosing tungsten carbide granules in a mild steel tube, provide a high level of abrasion resistance for hard facing use. H. S. Avery covered properties of such rods in his paper, "Some Characteristics of Composite Tungsten Carbide Weld Deposits". In the hard facing operation, the sheath tubing melts and dissolves both tungsten and carbon to form a hard matrix that anchors the very hard granules in place. Instead of being a mild steel binder for the tungsten carbide, as is sometimes believed, this matrix has characteristics that range from those of tungsten steel to cast iron structures containing considerable secondary tungsten-iron carbides. Abrasion resistance depends largely on the volume of undissolved carbides, and is generally better for gas welds. However, the hot hardness of arc welds is higher at 1200 F.

Automatic hard-facing is extremely valuable where there is a sufficient quantity of parts of like shape and size to be produced. The paper, "New Production Applications of Hard Facing", by E. C. Hurt, described machines for production line work that utilize welding rods applied by gravity and mechanical methods and also that make use of tungsten carbide powder which is fed from a hopper and distributed by torch flame.

Another new development using

B. F. Goodrich Chemical Company *raw materials*

B. F. Goodrich Chemical Company does not make this socket assembly. We supply raw materials for the coating only.

PARKING lamps and tail lights are living a longer, brighter life now—thanks to a new Geon plastisol-coated socket. This new development not only seals out dust and moisture from the socket assembly, but does away with such frequently unsatisfactory devices as boots, gaskets, grommets, etc.

This new socket, used in certain 1951 cars, is made possible because of the remarkable versatility of the plastisol coating made from Geon paste resin.

A single dip operation using Geon plastisol eliminates as many as three or four of the steps in the production of conventional socket assemblies. Many more automotive, electrical and mechanical parts can be similarly treated.

Note, too, these processing advantages with Geon paste resin. No solvents or expensive mixing equipment are needed. It is easily dispersed in plasticizers to make paste-like fluid. You can use it for dipping or coating, for molding or casting. Many attractive colors may be obtained.

Geon paste resin's adaptability may suggest a product or product improvement to you—a new way to make sales—a new way to solve materials problems. We make no finished products—supply raw materials only. But technical advice is ready at your call. Write Dept. **GL-1**, **B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco.**

Geon *Polyvinyl Materials*

A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY · A DIVISION OF THE B. F. GOODRICH COMPANY

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers

News Digest

News of Engineers

Victor E. Schlossberg has been appointed assistant chief engineer of the Indiana Harbor Works of Inland Steel Co. He had been superintendent of the electrical, power and steam departments, which will now be under the supervision of *Ryland J. Beeswy* and *Noah R. Kirkdoffer.* It was also announced that the following were transferred to inactive status under the Company's retirement plan: *Alfred J. Castle,* superintendent of the cold strip and tin mill departments of the Indiana Harbor Works; and *Harry C. Barnes* and *Stuart A. Koegle,* both assistants to Mr. Castle.

United States Rubber Co. has promoted *Frederick N. Taff* from mechanical engineer in charge of maintenance to the position of plant engineer of its Naugatuck, Conn., chemical plant. In the same division, Dr. *Harry Wintsch,* formerly production superintendent, was named assistant to the production manager. The new product manager of the L. H. Gilmer Div. of U. S. Rubber is *Wilbur E. Combs.* And *Elmer H. White,* vice president, was elected a director and member of the executive committee of the Company.

Dr. *Edward M. Pritchard* has joined the Control Engineering Corp. as chief electrical engineer.

The retirement of *George W. Vaught,* financial vice president of The B. F. Goodrich Co. since 1940, has been announced.

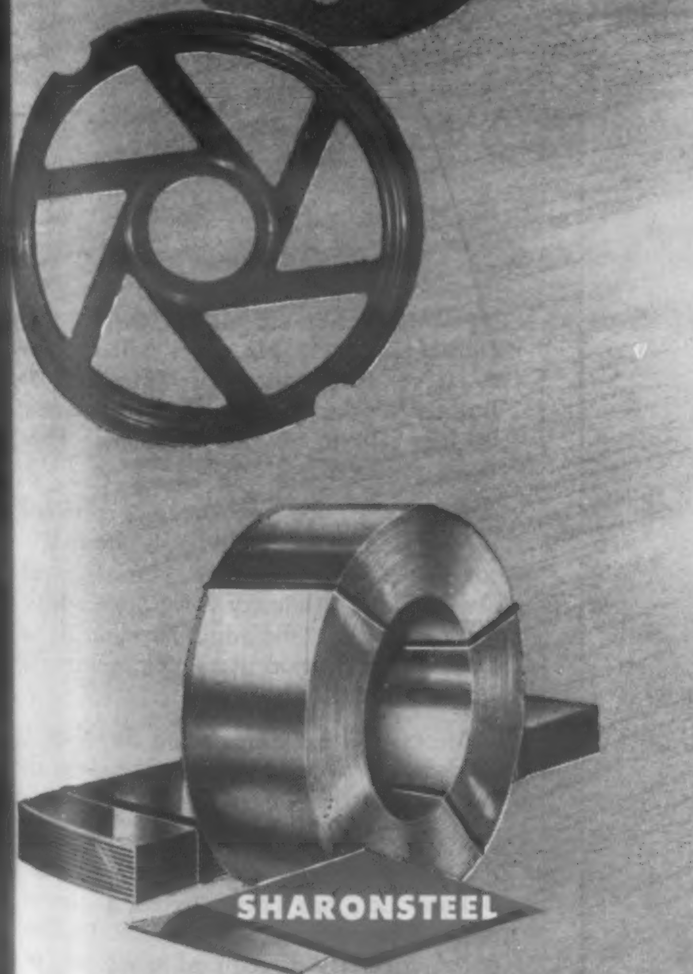
Robert A. Harris, assistant improvement engineer, was named chief improvement engineer of the Production Dept. of the American Car and Foundry Co. Another promotion was that of *Edmund A. Watson* from general improvement engineer to the position of assistant to the vice president. A.C.F. also announced that its subsidiary, Shippers' Car Line Corp., has elected *Harry J. Leddy* executive vice president and *John B. Davenport* vice president in charge of sales.

Herbert J. Werner has joined Columbia Machinery and Engineering Corp. as chief engineer of the Mechanical Press. Div.

Allis-Chalmers Manufacturing Co. has elected Dr. *H. K. Ihrig* vice president in charge of research. Dr. Ihrig resigned as vice president and director of laboratories of the Globe Steel Tubes Co. to accept the position with Allis-Chalmers.

Frank R. Simpson has been appointed director of research and development for The Kuljian Corp. For the past eight years Mr. Simpson has directed extensive research projects for the Franklin Institute of Philadelphia.

The promotion of *Thomas C. Gray* from



EDGE-HOLDING KNIVES of Sharon STAINLESS steel assure Grind-O-Mat owners fine cutting performance forever. Juices of the strongest variety will not harm the blades. The dense STAINLESS surface cleans easily, stays sanitary. STAINLESS steel has enabled Rival to build a better-performing, longer-lasting, better-selling product.

The beautiful new Rival Grind-O-Mat has everything — base that firmly grips any smooth surface without clamps — large, round food hopper that fits the hand and slopes for food drainage, detachable for quick rinsing — smooth attractive exterior, easy to keep sparkling clean — and cutting knives of edge-holding, non-rusting STAINLESS STEEL. No wonder folks who have used the new Grind-O-Mat say — "It's the 'grindingest' grinder ever!"

Sharon STAINLESS makes any product a better product. Think about STAINLESS for your particular use — and when you do — think of Sharon — pioneer and prime producer of fine steels for fifty years. Fabrication information, engineering data upon request.

SHARON STEEL CORPORATION *Sharon, Pennsylvania*

...CTS OF SHARON STEEL CORPORATION AND SUBSIDIARIES: THE NILES ROLLING MILL COMPANY, NILES, OHIO; DETROIT TUBE AND STEEL DIVISION, DETROIT, ...GAN; BRAINARD STEEL COMPANY, WARREN, OHIO; SHARONSTEEL PRODUCTS COMPANY, DETROIT, MICHIGAN, AND FARRELL, PENNA.; CARPENTERTOWN COAL ...E CO., MT. PLEASANT, PENNA.; FAIRMONT COKE WORKS, FAIRMONT, W. VA.; MORGANTOWN COKE WORKS, MORGANTOWN, W. VA.; JOANNE COAL ...NY, RACHEL, W. VA. Hot and Cold Rolled Stainless Strip Steel—Alloy Strip Steel—High Carbon Strip Steel—Galvanite Special Coated Products—Cooperage Hoop—...al Steel Sheets—Hot Rolled Annealed and Deoxidized Sheets—Galvanized Sheets—Enameling Grade Steel—Welded Tubing—Galvanized and Fabricated Steel Strip—Steel Strapping, Tools and Accessories.

...ICT SALES OFFICES: Chicago, Ill., Cincinnati, O., Cleveland, O., Dayton, O., Detroit, Mich., Indianapolis, Ind., Milwaukee, Wis., New York, N. Y., Philadelphia, Penna., Rochester, N. Y., Los Angeles, Calif., San Francisco, Calif., St. Louis, Mo., Montreal, Que., Toronto, Ont.

News Digest

manager of engineering production to the position of director of engineering for Pullman-Standard Car Manufacturing Co. was announced recently.

Lester C. Higbee has been appointed director of engineering of W. & L. E. Gurley. Mr. Higbee, who was recently elected secretary of the company, will continue as sales manager, the position he has held since 1945.

Sharon Steel Co. has appointed *Louis K. Whitcomb* as manager of product development. Mr. Whitcomb, who had been special representative for Sharon Steel, will be located in the Company's main office in Sharon, Pa.

Ralph S. Euler, senior vice president of Mellon National Bank & Trust Co., has been elected to the board of directors of Allegheny Ludlum Steel Corp.

United States Radiator Corp. has appointed Colonel *Miles H. Knowles* as vice president in charge of its defense production activities. He will make his headquarters in Washington.

Edward F. Doty, well known designer of screw and rotary pumps, has joined The Warren Steam Pump Co., Inc. He formerly was associated with Quimby Pump Co.

The Carpenter Steel Co. has promoted *John W. Thompson* from manager of sales development to the position of product manager.

Two new vice presidents have been named by Worthington Pump & Machinery Corp. They are *Austin C. Ross* and *Harold K. Beck*. Mr. Ross will continue to serve as manager of Worthington's Buffalo Works, and Mr. Beck will remain in his present post as manager of the Washington office.

Edward A. Livingstone, vice president in charge of sales of The Babcock & Wilcox Tube Co., has been named to the Steel Products Industry Advisory Committee, to advise in the administration of the Defense Production Act as it affects the iron and steel industry.

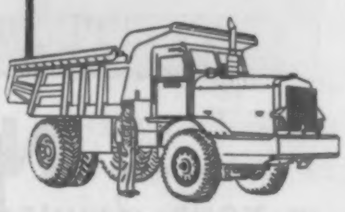
Mercast Corp. has elected *Seymour J. Sindeband* an executive vice president. He was formerly technical director of American Electro Metal Corp.

Frank U. Hayes, sales manager of The Bullard Co., has been elected a director of the Company. He succeeds *E. P. Blanchard*, formerly director of sales, who retired after 30 years with Bullard.

International Derrick & Equipment Co. has appointed *C. Edwin Ponkey* general manager of its Columbus Div., to succeed *Ferguson Barnes*, who recently resigned. Mr. Ponkey was formerly vice president of the Sheldrick Manufacturing Corp.

Elmer Gammeter, chief metallurgist,

MUREX *Speeds Welding of* EUCLID EQUIPMENT



Fast, easy-to-use, Murex Genex electrodes speed production of welded frames for heavy duty earth moving equipment built by The Euclid Road Machinery Co. And, their nearly spatter-free operation reduces weld cleaning time to a minimum.

Many of America's leading fabricators have standardized on Murex electrodes because of their ability to provide high quality welds at low cost. Let us put you in touch with Murex performance today. Descriptive literature—yours for the asking.

MUREX
ELECTRODES

METAL & THERMIT CORPORATION
100 E. 42nd ST. · NEW YORK 17, N. Y.

NEWARK
PHILADELPHIA
PITTSBURGH
CLEVELAND
E. CHICAGO, IND.
MINNEAPOLIS
SO. SAN FRANCISCO

News Digest

was appointed director of laboratories for the Globe Steel Tubes Co.

Lewis John Firth, a pioneer of the tool steel industry in this country and founder of Firth Sterling Steel Co., died at the age of 92 after a prolonged illness.

The Babcock & Wilcox Co. has announced the sudden death of *Charles Henry Woolley,* assistant manager of its Proposition Dept.

News of Companies

Purchase of the *R-S Products Corp.,* Philadelphia, by *S. Morgan Smith Co.,* York, Pa., has been announced. There will be no change in the personnel or operation of the Philadelphia concern.

Sintercast Corp. of America has moved its office, laboratory and production facilities from New York City to larger quarters at 134 Woodworth Ave., Yonkers 2, N. Y.

The formation of *Microwave Associates, Inc.* as a corporation to provide consulting, design and manufacturing facilities for electronic equipment operating in the microwave region has been announced. The new concern is located at 303-30? Columbus Ave., Boston 16, Mass.

American Cyanamid Co., New York 20, has just acquired a lease to a new building now being constructed near the corner of Addison and Kimball Sts., Chicago, and scheduled for completion by March, 1951. Consolidation of various offices and warehouses located throughout Chicago is the main purpose of this transaction.

A New England branch plant on Poquonock Rd., Groton, Conn., has recently been opened by *Arwood Precision Casting Corp.,* Brooklyn 1, N. Y. This new plant will double the firm's production capacity.

H. K. Porter Co., Inc., Pittsburgh, Pa., has announced the formation of the Jarecki Valve Div. in Tulsa, Okla., to handle the manufacture and sale of Jarecki valves formerly produced at the Jarecki Manufacturing Co., Erie, Pa.

Construction of a new plant at Union, N. J., by *Air Reduction Sales Co., Inc.* has been announced. The new facilities will be used by the Airco Equipment Manufacturing Div. of Air Reduction, and should be ready for occupancy early next spring.

Kropp Forge Co., Chicago, has acquired the forge plant at Melvindale, Mich., belonging to the Ordnance Tank Automotive Center of Detroit, and formerly occupied by the Timken-Detroit Axel Co.

Stainless requires careful selection, too!

Before you marry your product to stainless steel, make certain that you've chosen the right analysis. *Stainless* is a broad term applied to a whole host of steels, each with its own characteristics. And to get the most out of stainless you must select with care.

That's why Crucible, a pioneer in the development of this specialty, offers you the services of a staff of metallurgists, well qualified by experience with hundreds of applications, to help you put stainless to work properly.

For more than half a century, Crucible has been the leader in the specialty steel field. There is no substitute for Crucible background — take full advantage of it. When you think of stainless — call in Crucible. CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

CRUCIBLE first name in special purpose steels

STAINLESS STEELS

51 *years of* Fine *steelmaking*

STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

News Digest

Kropp will produce forgings for Army Ordnance at the new facilities.

Plans to use a large tract on the Neuse River, near Kinston, N. C., for the manufacture of a new synthetic fiber known tentatively as Fiber V, instead of nylon, has been announced by *E. I. du Pont de Nemours & Co. (Inc.)*, Wilmington, Del. Construction is to start sometime this year.

News of Societies

The following officers to serve the year 1951 were recently elected by the *Institute of the Aeronautical Sciences*: president—Lawrence B. Richardson, Rear Admiral, U.S.N. (Ret.); vice presidents—Raymond D. Kelly, United Air Lines, Inc; William C. Rockefeller, Consolidated Vultee Aircraft Corp.; William T. Schwendler, Grumman Aircraft Engineering Corp.; and Edward C. Wells, Boeing Airplane Co.; and treasurer—E. E. Aldrin, Atlas Supply Co. Reelected as director was S. Paul Johnston, Robert D. Dexter as secretary, and Joseph J. Maitan as controller.

Dr. Hans H. Bleich has been appointed an associate professor of civil engineering at *Columbia University*, where he has been a lecturer on civil engineering since 1946.

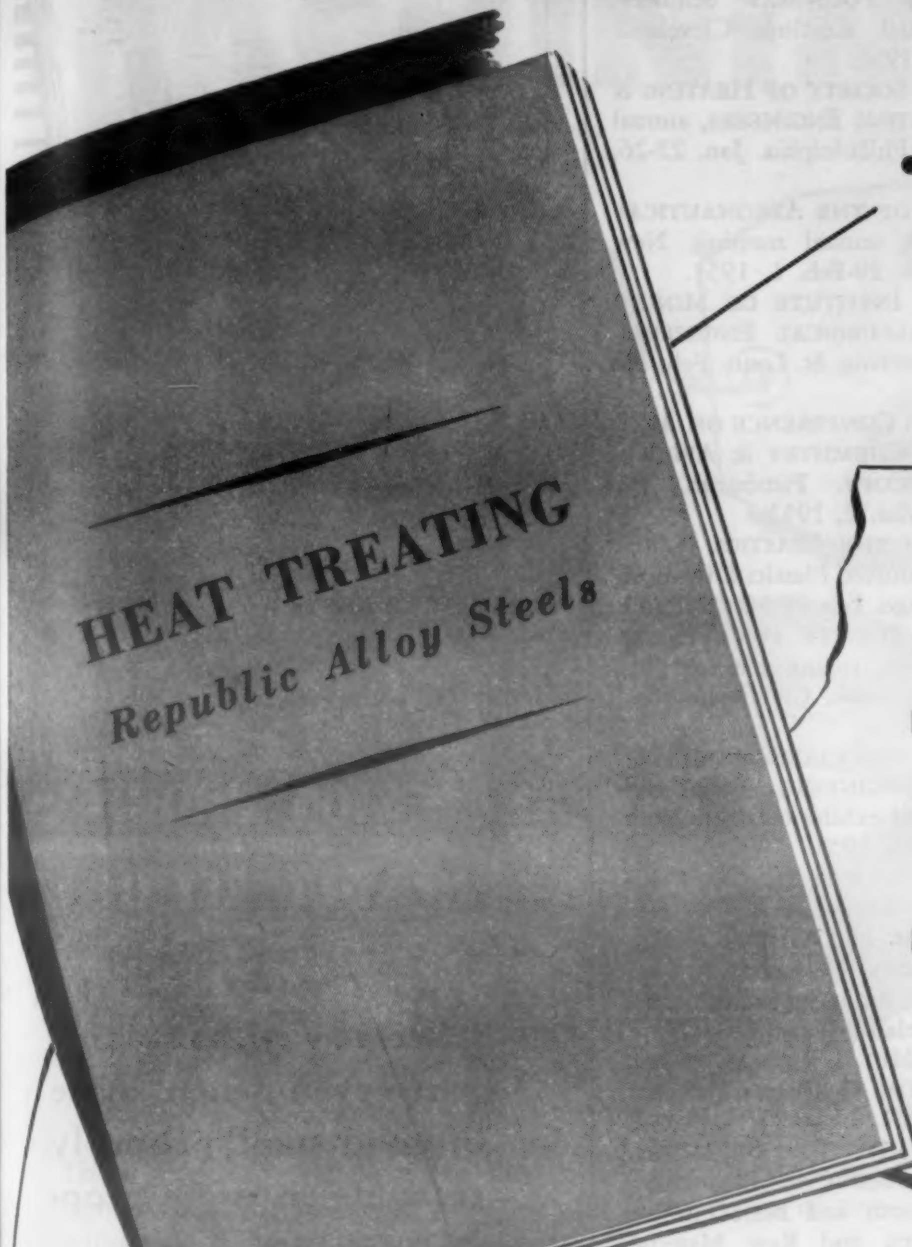
The *Gas Appliance Manufacturers Assn.* elected D. R. Meckstroth, director of sales research for Servel, Inc., chairman of the General Marketing Committee for the coming year. Vice chairman of this committee is L. C. Reese, vice president and general manager of Armstrong Products Corp.

The *American Society of Tool Engineers* recently chartered its 86th chapter, located in Dover, N. H.

The Franklin Institute has announced the following appointments: Dr. Nicol H. Smith was named executive director of the Institute's Laboratories for Research and Development. Dr. C. T. Chase is now associate director for chemical engineering and physics. L. P. Tabor becomes associate director for electronics and instruments. And J. J. Boericke assumes the position of associate director of the contracts division.

The election of officers for the *Association of Consulting Chemists and Chemical Engineers, Inc.* occurred during the annual meeting of the Society. They include: president—Erwin Di Cyan, Di Cyan & Brown; vice president—Earl D. Stewart, director of research, Schwarz Laboratories, Inc.; treasurer—Robert S. Aries, Robert S. Aries & Associates; and secretary—Albert P. Sachs, consulting chemical engineer.

If you use Alloy Steels...



...you should have this NEW helpful booklet!

TABLE OF CONTENTS

It's new . . . up-to-the-minute . . . 54 pages of valuable heat treating data that belongs on the desk of every alloy steel user.

Republic—world's largest producer of alloy and stainless steels—offers you this useful booklet without cost or obligation in any way.

Just fill in the coupon and mail *today.*

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
Advertising Division
3110 East 45th Street, Cleveland 27, Ohio

Please send me a copy of your new booklet *Heat Treating Republic Alloy Steels.*

Name .... *Title* ....

Firm ....

Address ....

City .... *State* ....

Meetings and Expositions

SOCIETY OF PLASTICS ENGINEERS, INC., national conference. New York. Jan. 18-20, 1951.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland. Jan. 19, 1951.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Philadelphia. Jan. 22-26, 1951.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York. Jan. 29-Feb. 1, 1951.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. St. Louis. Feb. 18-22, 1951.

PITTSBURGH CONFERENCE ON ANALYTICAL CHEMISTRY & APPLIED SPECTROSCOPY. Pittsburgh, Pa. Feb. 28-Mar. 2, 1951.

SOCIETY OF THE PLASTICS INDUSTRY, Reinforced Plastics Div. meeting. Chicago. Feb. 28-Mar. 2, 1951.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting and committee week. Cincinnati. Mar. 5-9, 1951.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference and exhibition. New York. Mar. 13-16, 1951.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. New York. Mar. 14-17, 1951.

INSTITUTE OF THE AERONAUTICAL SCIENCES, flight propulsion meeting. Cleveland. Mar. 16, 1951.

WESTERN METAL CONGRESS AND EXPOSITION. Oakland, Calif. Mar. 19-23, 1951.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace, Coke Oven and Raw Materials conference, Iron and Steel Div. Cleveland. Apr. 2-4, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Atlanta, Ga. Apr. 2-5, 1951.

ELECTROCHEMICAL SOCIETY, spring meeting. Washington, D. C. Apr. 8-11, 1951.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS, national convention. Philadelphia. Apr. 16-18, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Process Industries conference. Baltimore, Md. Apr. 17-19, 1951.

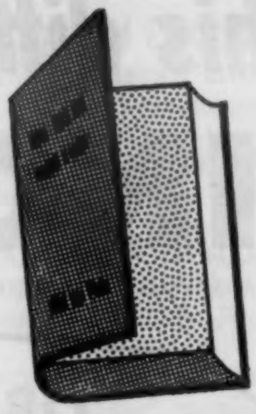
AMERICAN MANAGEMENT ASSOCIATION, annual packaging exposition. Atlantic City, N. J. Apr. 17-20, 1951.

AMERICAN CERAMIC SOCIETY, annual meeting. Chicago. Apr. 22-26, 1951.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Buffalo, N. Y. Apr. 23-26, 1951.

METAL POWDER ASSOCIATION, annual meeting and exhibit. Cleveland. Apr. 25-26, 1951.

MATERIALS HANDLING EXPOSITION. Chicago. Apr. 30-May 4, 1951.



BOOK REVIEWS

Treatise on Powder Metallurgy — Volume II

APPLIED AND PHYSICAL POWDER METALLURGY. *By Claus G. Goetzel. Published by Interscience Publishers, Inc., New York, 1950. Cloth, 6¼ by 9¼ in., 910 pages. Price $18.00.*

This is Volume II of Dr. Goetzel's comprehensive and voluminous work on powder metallurgy technology. Another is yet to come. But since it will consist of a classified and annotated bibliography, Volumes I and II are really the meat of the subject.

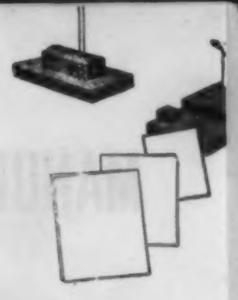
Volume II covers two principal aspects of powder metallurgy. Part 1 is devoted to the practical applications of powder metallurgy in industry. Ten chapters treat the variety of industrial materials and products. They are: refractory metals and alloys, hard metals and compositions, electrical materials and products, magnetic materials and products, ferrous and non-ferrous materials for structural parts, porous products, friction products, dental alloys, and miscellaneous applications for metal powders. In each case the properties and characteristics are discussed in detail, and the methods of manufacture are described.

Part 2 of the book is devoted to physical powder metallurgy, and covers practical evaluations and theoretical analyses of the materials, products and processes. Some of the subjects covered include comparison of physical properties of sintered and fused industrial metals and alloys, stress analysis of sintered metal structures, testing methods, survey of sintered metals and alloys for potential industrial use, and a summary of the theories of bonding and sintering.

Other New Books

MODERN REFRACTORY PRACTICE, THIRD EDITION. *Edited by J. Spotts McDowell. Published by the Harbison-Walker Refractories Co., Pittsburgh, Pa., 1950. Cloth, 8 by 11 in., 439 pages. Price $6.00, but free of charge to users of refractories, to libraries, and to faculty members of universities and colleges.* This completely re-written third edition, which

(Continued on page 164)



MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Stainless Steel Design. Allegheny Ludlum Steel Corp. New book discusses, in detail, applications of high tensile stainless steel in structural design. (1)

Tool Steels. Bethlehem Steel Co. Properties, selection data and heat treating information about this company's tool steels. (2)

Steel Design. Climax Molybdenum Co., 72 pp. Booklet tells how to combine good design, high quality steel and proper treatment for best results with steel components. (3)

Stainless Steels. Peter A. Frasse & Co., Inc., No. 5. Comparative results of tests for resistance to sensitization of five extra low carbon stainless steels. (4)

Steel Flats. W. J. Holliday & Co., 6 pp, ill, No. 446. Properties of Speed Treat medium carbon steel and its use as hot rolled flats. Includes table of specifications. (5)

High-Strength, Low-Alloy Steel. Jones & Laughlin Steel Corp., 32 pp, ill. Complete data on Otiscoloy, widely used in the transportation industry. (6)

Clad Steels. Lukens Steel Co., 2 pp, ill, No. 540. Describes economies available through use of chromium- and nickel-clad steel. (7)

Alloy Steel. Joseph T. Ryerson & Son, Inc., 2 pp. Describes Ledloy, lead-bearing steel said to machine 30 to 50% faster than fastest previously available screw steel. (8)

Nonferrous Metals

Aluminum and Its Alloys. Aluminum Co. of America, 154 pp, ill, No. AD51. Data on aluminum and its alloys, including heat treatment, available forms, design and fabricating practices. (9)

Bronze Alloys. American Manganese Bronze Co., 46 pp. Data on properties and specifications of bronze alloys for casting. Request direct from company on business letterhead.

Bonded Metals. American Nickeloid Co., 16 pp, ill. Fabricating information and suggestions, applications and tables of properties and sizes of Nickeloid Metals. (10)

Spring Alloy. Elgin National Watch Co., Industrial Products Div., 2 pp. Composition and properties of Elgiloy, cobalt-chromium-base spring alloy. (11)

Nickel-Base Alloys. Haynes Stellite Div., Union Carbide and Carbon Corp., 40 pp. Properties, specifications and uses of Hastelloy corrosion resistant grades. (12)

Electrical Resistance Alloy. The C. O. Jelliff Mfg. Co. Engineering data on Jelliff Alloy 1000, said to have outstanding electrical and mechanical properties. (13)

Bronze Bars. National Bearing Div., American Brake Shoe Co., 6 pp, ill. Sizes and approximate weights of as-cast and machined, cored and solid bars of N-B-M "Tiger" Bronze. (14)

Aluminum Rods and Bars. Reynolds Metals Co., Aluminum Div., 4 pp, ill, No. AD 400-15-749. Tables of properties, alloys, tempers and specifications of aluminum rod, bar and forging stock. (15)

Alloy Specifications. The Riverside Metal Co. Data sheet correlates ASTM, Federal, Army and Navy specifications for 40 of this company's nonferrous alloys. (16)

Nonmetallic Materials • Parts

Porcelain Insulators. The Akron Porcelain Co., 6 pp, ill. Numerous electrical insulators of various porcelains. Briefly describes engineering properties of porcelain. (17)

Felt Seals. American Felt Co. Data Sheet No. 11 gives detailed design factors and applications of felt seals. (18)

Hard Rubber. American Hard Rubber Co., 60 pp. Manual gives detailed selection data on hard rubber and plastics materials. (19)

Ceramics. American Lava Corp., 4 pp, No. 501. Detailed chart of mechanical and electrical properties of AlSiMag vitreous ceramics, lava and refractories. (20)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 161

Extruded Plastics. The Anchor Plastics Co., 8 pp, ill, No. AP51. Shows numerous applications of extruded thermoplastics and brief characteristics to aid in selection. (21)

Phenolics. The Borden Co., Chemical Div. Catalog gives properties, uses and advantages of Durite phenolics with broad range of useful characteristics. (22)

Porcelain Products. The Colonial Insulator Co., 12 pp, ill. Shows wide range of custom made porcelain products, including insulators, forms for dipped rubber goods, and kitchen appliances. (23)

Precision Molded Plastics. Consolidated Molded Products Corp., 8 pp, ill. Describes facilities and equipment for producing molded plastics parts. (24)

Plywood. Douglas Fir Plywood Assn., 32 pp, ill. Series of articles shows how to use plywood effectively in fixtures, displays, posters and signs. (25)

Plastics. E. I. du Pont de Nemours & Co. (Inc.), 10 pp, ill, No. 113/3. Descriptions, advantages and uses of Lucite, Polythene Nylon, Butacite, Pyralin, Plastacele and Teflon. (26)

Plastics. Durez Plastics & Chemicals, Inc. *Durez Plastics News* gives timely reports on industrial applications and developments of Durez plastics. (27)

Cellulose Ester Materials. Eastman Kodak Co., Cellulose Products Sales Div., 8 pp, ill, No. H-1-10. Data and specifications for Kodapak Sheet, thermoplastic cellulose ester with good electrical qualities. (28)

Plastics and Metal Parts. The Electric Auto-Lite Co., Bay Mfg. Div., 16 pp, ill. Shows wide variety of custom made ornamental and functional metal and plastics parts. (29)

Flexible Tubing. Flexible Tubing Corp., 8 pp, ill, No. 16/13. Characteristics, uses and properties of this company's various molded and laminated plastics. (30)

Metal Hydrides. Metal Hydrides, Inc., 4 pp. Describes metallurgical and chemical hydrides, their use in alloying, hydrogen production, reduction of compounds, etc. (31)

Carbon Products. Morganite, Inc., 8 pp, ill, No. 1f. Specifications of various carbon bearings and bushings. Also properties of

MANUFACTURERS' LITERATURE

six series of Morganite carbon products. (32)

Corrosion Resistant Materials. Nukem Products Corp., 36 pp, ill. Properties, applications and descriptions of Nukem acid-proof cements, floors and tanks. (33)

Alkyd Molding Compound. Plaskon Div., Libbey-Owens-Ford Glass Co., 16 pp, ill, No. 7131. Properties and characteristics of Plaskon Alkyd fast-molding compound. (34)

Molded Parts. Resistoflex Corp., 4 pp, ill, No. 4g/3. Properties and uses of this company's nonmetallic custom-molded parts and resinous-lined, reinforced industrial hose. (35)

Impact Phenolics. The Rogers Corp. Booklet shows various types of Fiberloys, including molding compounds in sheet and bulk form, laminated plastics and paperboards. (36)

Plexiglas for Glazing. Rohm & Haas Co. Booklet gives details on applications, workability and economies of Plexiglas for glazing purposes in factories, housing and hotels. (37)

Sponge Rubber Products. Sponge Rubber Products Co. Shows properties, forms and wide applications of cellular rubber for cushioning, gasketing, sealing, etc. (38)

Technical Plastics. Synthane Corp., 20 pp, ill, No. 16/15. Properties, available forms, specifications and applications of this company's technical plastics described. (39)

Ceramic Laboratory Ware. The Thermal Syndicate, Ltd. Technical descriptions, specifications and prices of Vitreosil ware, said to be superior to porcelain in some uses. (40)

Inert Plastic. U. S. Gasket Co., Teflon Products Div., No. 300. Description and specifications of available stock of Teflon, chemically inert, electrically resistant plastic. (41)

Nonmetallic Gear Material. Westinghouse Electric Corp., Micarta Div., 16 pp, ill. Manufacturing, machining and application data on Micarta, resin impregnated fabric gear material. (42)

Metal Parts • Forms

Precision Investment Castings. The Adapti Co., 4 pp, ill, No. C-2M. Close tolerances and stronger metals are among advantages listed of Adapti Method of precision casting. (43)

Flexible Metal Hose. Allied Metal Hose Co., 20 pp, ill, No. 942. Applications, engineering data and other details on company's stainless steel, bronze and steel flexible hose. (44)

Precision Castings. Alloy Precision Castings Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows numerous products. (45)

Aluminum Extrusions. Aluminum Co. of America. Design potentials of extrusion process and cost savings in fabrication and assembly of extrusions explained. (46)

Aluminum Parts. Aluminum Goods Mfg. Co., 56 pp, ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (47)

Zinc Die Castings. American Die Casting Institute. Bulletin describes Certified Zinc Alloy Plan, explaining benefits to die casting buyers. (48)

Nonferrous Plaster Mold Castings. Atlantic Casting & Engineering Corp., No. 4. Describes production of copper-base and aluminum alloy "Atlanticastings." (49)

Heat Exchanger Tubes. The Babcock & Wilcox Tube Co., 6 pp, ill, No. TB-329. Properties, specifications and applications of company's grades of seamless and welded heat exchanger and condenser tubing. (50)

Small Tubular Parts. The Bead Chain Mfg. Co. Describes Multi-Swage Process for economically custom producing small mechanical parts up to ¼-in. dia and 2-in. length. (51)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrication and specifications. (52)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pp, ill. Physical properties, corrosion resistance and available sizes of this company's stainless tubing. (53)

Powdered Metal Parts. Chicago Metal Products Co., 4 pp, ill. Properties and advantages of Camet custom-molded powdered metal parts. Includes design types. (54)

Stainless Valves. The Cooper Alloy Foundry Co., 48 pp, ill. Catalog gives complete line of firm's stainless valves, fittings and accessories. Includes design information. (55)

Magnesium Die Castings. Doehler-Jarvis Corp., 4 pp, ill. Physical properties, applications and advantages of Doler-Mag magnesium die castings. (56)

Plastic Lined Fittings. The Dow Chemical Co., 32 pp, ill, No. SL6-N-250. Properties, design data and applications of Saran lined steel and iron pipe fittings and valves. (57)

Forgings. Drop Forging Assn., 60 pp, ill. Data book shows mechanical qualities of forgings, and illustrates economic, engineering and production advantages available. (58)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (59)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (60)

Corrosion Resistant Castings. Electro-Alloys Div., American Brake Shoe Co., No. T-171. Properties and engineering uses of Chemalloy corrosion-resistant alloys for casting. (61)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill. Describes Graphalloy grades for bushings and electrical uses. Bearing design data included. (62)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision-cast brass, bronze, beryllium copper and steel. (63)

Zinc Die Castings. Gries Reproducer Corp., 4 pp, ill. Specifications of corrosion resistant nonferrous zinc alloy wing nuts, small zinc die castings and injection moldings. (64)

Iron Castings. Hunt Spiller Mfg. Corp. Properties and descriptions of Gun Iron and many other metals for casting. (65)

Precision Cast Parts. The Jelrus Co., Inc. Advantages of centrifugal precision casting for custom manufacture of complex parts accurately and quickly. (66)

Sleeve Bearings. Johnson Bronze Co. Series of data sheets gives detailed design, construction and testing data on sleeve bearings. (67)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Tables of reel sizes given. (68)

Steel Castings. Lebanon Steel Foundry. Data sheets give design aids for making good steel and alloy castings. Include properties and chemical analyses of alloys. (69)

Aluminum Extruded Shapes. Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (70)

Die Castings. Litemetal Die Cast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (71)

Gray Iron Castings. Meehanite Metal Corp., 8 pp, ill, No. 31. Applications and engineering data on casting. Shows specific applications for Meehanite gray iron castings. (72)

Precision Castings. Microcast Div., Austenal Laboratories, Inc., 16 pp, ill. Describes Microcast precision investment casting and shows, by wide range of custom made parts, advantages of process. (73)

Nonferrous Powder Parts. The New Jersey Zinc Co., 28 pp, ill. Applications and

MANUFACTURERS' LITERATURE

of driving and tightening Palnut self-locking nuts. Lists specifications of special wrenches. (137)

Bolts, Nuts and Studs. Pawtucket Mfg. Co., 28 pp, No. 46. Complete price catalog of this company's fasteners of brass, bronze, stainless steel and monel. (138)

Special Nuts. Shakeproof, Inc., 12 pp, ill. Detailed description of Keps, nuts and lockwashers constructed in a single unit in standard sizes. Shows numerous advantages. (139)

Special Fasteners. South Chester Corp., Southco Div., 6 pp, ill, No. SCO 12. Descriptions and specifications of special fasteners for unique fastening applications. (140)

Self-Locking Nuts. Standard Pressed Steel Co., ill. Features and applications of Flexloc locknuts, listing prices and specifications of popular sizes. (141)

Forming • Casting • Molding Machining

Metal Forming Process. Hydropress, Inc., 8 pp, ill, No. L-58. Detailed description of Marform process for forming accurate sheet metal parts. Applications and cost analysis included. (142)

Tungsten Carbide Blades. Metal Carbides Corp. No. 48WP. Prices, specifications and sizes of Talide tungsten carbide centerless blades claimed to have exceptionally long service life. (143)

Plastics Molding Press. F. J. Stokes Machine Co., 4 pp, ill, No. 503. Description and specifications for automatic plastics press. Typical products shown. (144)

Inspection • Testing • Control

Hardness Tester. Ames Precision Machine Works, 6 pp, ill. Describes portable precision hardness tester Model 4 for testing rounds and flats up to 4 in. (145)

Fatigue Testing Machine. The Baldwin Locomotive Works, 2 pp, ill, No. 313. Operating principle, specifications and applications of Sonntag SF-4 Fatigue Machine. (146)

Ultrasonic Tester. The Brush Development Co., 4 pp, ill. Operating principle and uses of the "Hypersonic" Analyzer for nondestructive inspection of materials. (147)

Nondestructive Inspection. Dy-Chek Co., 4 pp, ill, No. 500. Describes simple method for nondestructive inspection of metal parts using penetrant dye. (148)

Radium Radiography. Eldorado Mining & Refining (1944), Ltd., P. O. Box 379, Ottawa, Canada, 71 pp, ill, price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Eldorado.

Pocket Thickness Gage. Ferro Enamel Corp. Describes pocket size thickness gage said to give good accuracy for measuring nonmagnetic coatings on ferrous surfaces. (149)

Temperature Controls. Claud S. Gordon Co., 4 pp, ill. Data on specifications and advantages of Xactene indicating and recording temperature controls. (150)

Dewpoint Indicator. Illinois Testing Laboratories. Describes Alnor Dewpointer for checking simply and accurately the dew point of gases generated for heat treating. (151)

Repeated Stress Testing Machines. Krouse Testing Machine Co., 8 pp, ill, No. 46-C. Detailed description of repeated stress testing machines and accessories. Includes specifications. (152)

Magnetic Inspection. Magnaflux Corp., 4 pp, ill, No. B-414-2. Describes method of locating flaws in magnetic metal parts using fluorescent paste and black light. (153)

Testing Machines. Scott Testers, Inc., 66 pp, ill, No. 50. Catalog gives details on complete line of instruments for testing mechanical properties of materials. (154)

Rubber Testing. V. L. Smithers Laboratories, 16 pp, ill. Describes facilities for testing chemical, physical and mechanical properties of rubber, synthetic rubber and rubber-like materials. (155)

Ultrasonic Tester. Sperry Products, Inc., 4 pp, ill, No. 50-105. Principle, applications, advantages and directions for use of Reflectoscope in nondestructive testing of materials. (156)

Abrasion Testing Set. Taber Instrument Corp., 6 pp, ill, No. 5003. Shows equipment and applications of Model 140 Abraser for testing abrasion resistance of surfaces. (157)

Thermocouples. Thermoelectric Co., Inc. Catalog Section 22G shows this firm's line of thermocouples and accessories for numerous industrial uses. (158)

Versatile Testing Machine. Tinius Olsen Testing Machine Co., No. 40. Data on the Olsen Super "L" testing machine with 50 to 1 spread of testing ranges. (159)

General

Ultrasonic Equipment. The Brush Development Co., 4 pp, ill, No. F-267. Uses and specifications of Hypersonic Equipment for such uses as emulsification, dispersion and degassing. (160)

Motor-Generator Sets. General Electric Co., Apparatus Dept., 8 pp, ill, No. GEA-5506. Features of G-E motor-generator sets for such uses as metal-rolling mill motors. (161)

Book Reviews

(continued)

covers all phases of the subject of industrial refractories, is a practical engineering handbook, a comprehensive technical treatise, and a catalog of the Company's products, combined in a single volume.

Steel Castings Handbook. *Prepared under the direction of the SFSA Handbook Committee. Published by Steel Founders' Society of America, Cleveland 15, Ohio, 1950. Cloth, 6 by 9¼ in., 511 pages. Price $4.00.* This excellent reference book is a very extensive revision of the 1941 edition, and includes much unpublished information made available by qualified individuals and corporations, both within and outside the steel casting industry.

Casting and Forming Processes in Manufacturing. *By James S. Campbell, Jr. Published by the McGraw-Hill Book Co., New York 18, N. Y., 1950. Cloth, 6¼ by 9¼ in., 536 pages. Price $5.00.* This text covers as thoroughly as possible in one book all the casting processes, plastics-molding and forming, powder metallurgy, rolling, forging, sheet-metal working and punch-press operations, with special emphasis on both the design and the modern mass-production viewpoints.

Data on Corrosion- and Heat-Resistant Steels and Alloys—Wrought and Cast. *Prepared by Russell Franks, J. W. Juppenlatz, V. N. Krivobok, F. L. LaQue, F. P. Peters and E. A. Schoefer. Published by the American Society for Testing Materials, Philadelphia 3, Pa., 1950. Paper, 6 by 9 in., 79 pages. Price $2.50.* Special Technical Publication No. 52-A contains new tables of data on the compositions and properties of the wrought corrosion and heat resistant chromium and chromium-nickel steels and alloy castings, assembled by Subcommittee I on Classification of Data of the ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.

Metals and Alloys. *By the Technical Staff of Metal Industry. Published by Chemical Publishing Co., Inc., Brooklyn 2, N. Y., 1950. Cloth 5½ by 8¾ in., 214 pages. Price $5.00.* An up-to-date reference book, listing in tabular form the composition of some 4600 alloys.

The Extraction of Non-Ferrous Metals. *By E. R. Roberts. Published by Temple Press, Ltd., London, England, 1950. Cloth, 5½ by 8¾ in., 181 pages.* Price 16/-. The physico-chemical aspects and the general practice of extraction methods are discussed in detail, followed by brief accounts of the extraction of individual metals.

Handbook of Experimental Stress Analysis. *Edited by M. Hetenyi. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1950. Cloth, 6¼ by 9¼ in., 1077 pages. Price $15.00.* A unified presentation of all existing experimental methods for the determination of mechanical strength, written by 31 top rank stress analysts.

Papers on Radiography. *Published by American Society for Testing Materials, Philadelphia 3, Pa., 1950. Paper, 100 pages. Price $1.75.* Papers and discussions of a session to correlate late developments of radiography, presented at the annual meeting of the ASTM in 1949, are included in this Special Technical Publication No. 96.

Indium. *By Maria Thompson Ludwick. Published by The Indium Corp. of America, New York, N. Y., 1950. Cloth, 6 by 9¼ in., 276 pages. Price $7.50.* A comprehensive working reference volume that covers the discovery, occurrence, development, and physical and chemical characteristics of indium, and includes a bibliography (annotated) from 1863 to 1949, inclusive.

Procedure Handbook of Arc Welding Design and Practice. 9th Edition. *Published by The Lincoln Electric Co., Cleveland 1, Ohio, 1950. Cloth, 6 by 9 in., 1200 pages. Price $2.00.* This 9th Edition of the Handbook has been completely reorganized and re-edited to bring all information up-to-date and include recent important welding developments.

Heat Treatment and Properties of Iron and Steel. *By Samuel J. Rosenberg and Thomas G. Digges. Published by the National Bureau of Standards, U. S. Dept. of Commerce, Washington 25, D. C., 1950. Paper, 33 pages. Price $.25.* Basic theoretical and practical principles involved in the heat treatment of ferrous metals is presented in simplified form in this circular.